

#31

PLANTS FOR USE IN PERMACULTURE IN THE TROPICS

By Franklin W. Martin



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Plants for Use in Permaculture in the Tropics

by

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Introduction

Current systems of development of the world's resources are exploitive and can be seen to be destroying the environment for people as well as for plants and animals in order to obtain short term benefits. Obviously, such systems will have to change, although it is not yet clear whether we ourselves will initiate sound changes for our own long term benefits, or whether the destruction will go so far as to force change upon us, with disastrous results. A relatively few alert and dedicated people are trying in many ways to initiate desirable changes now. Tremendous efforts to educate and change are very necessary. An improved life style ought to include a set of ethics for today's and tomorrow's world, and should give hope to humanity.

Permaculture is one approach to ecologically sound agriculture, land use and life style. The copyrighted word, "Permaculture", permanent agriculture, is a concept of land utilization based on the use of perennial and multiple purpose crops, in which diversity of crops, design, and harmonious interactions preserve and enrich the environment while limiting work input. While this manuscript has been written with Permaculture in mind, nevertheless, the information will be useful for anyone planning one's own food production system or a small farm in the tropics.

The Uses of Plants and Priority of Use

Plants are used by people for their own benefit in a large number of ways. Some of these ways are listed below:

- For one's immediate personal needs:
 - as food
 - as condiment
 - as medicine
 - as feed for farm animals
 - as sources of nectar and pollen for bees.
- For one's supplemental needs:
 - as fiber for clothing
 - as construction material
 - as fuel for cooking and heating.
- For protection of one's home, Earth:
 - by soil enrichment
 - nitrogen fixation
 - deep mineral recycling
 - addition of organic matter
 - by control of erosion
 - by microclimate modification
 - shade
 - windbreak
 - attraction of moisture.
- for wildlife habitat and feeding.
- for control of pests
 - by companion crops
 - by use as pesticides.

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- for the development and appreciation of beauty.

In order to use our plant heritage wisely, we need to know the uses of plants, their availability, and dangers to them. We must also take active steps to conserve them for our use and the use of future generations. The knowledge of plants and their uses is a vast body of information that no person can entirely know, and that no single book holds.

In this presentation, an attempt is made to summarize and make available in simple form a wide range of information. Plants that have been selected for inclusion here are all very important or potentially important plants of the tropics, and the majority have several to many uses. These plants are summarized in Tables 1-4. In addition, some of these plants, mostly those with multiple uses, have been distinguished by the inclusion of about a page of information. This information includes names, principal use, brief description, climatic adaptation, principal yields, use for special purposes, culture, special problems, toxic characteristics, and other information.

The reader may find that many useful plants are not included here. Wheat, for example, is the most important food crop of the world, but in general is not suitable for the small food production system or the small farm or permaculture system, and does not have significant other uses. Other species have not been included for any of a number of reasons: excessive size, slow growth, poor quality, or less value than other species already included.

Species or varieties of plants identified by the reader as potentially useful can be sought first locally, in the neighbors' yards, in parks, in botanical gardens, in private collections, in experiment stations, and in extension offices. One might have to consult seed catalogs or special references, such as *Cornucopia, a Source Book of Edible Plants* by Stephen Facciola.

A permaculture system may consist of many, even hundreds of useful species of plants. While plants have a wide variety of uses, these uses are not of equal importance to people. It would be very desirable to have a system of ratings to help one distinguish the really valuable plants for one's own situation. Judgment of value is complicated by the fact that usefulness will depend on location as well as on personal needs or preferences. Furthermore, judgment also will be continuously modified by new experience. Thus, there are not, and cannot be, final answers to the comparative value of different plant species.

The scheme of priority of uses given here depends on the assumption that, for people, their own long term health and survival are of the utmost importance. Thus, the priorities assigned to plants follow the above list of uses: food, feed, supplemental needs, and protection of the ecology. Such judgments have been used in selecting plants for this manuscript. No treatment can be complete. Thus, the author must apologize for those favorite plants of others that are left out, and for omissions due to error and ignorance.

Plants as Sources of Food

Food is something more than just that which will satisfy the appetite. Food is the source of the construction materials to build and to repair the body itself, and of the fuel to keep vital processes operating. With respect to their relationships to life, food substances can be classified as follows below. If a person knows food requirements, relative amounts, and their sources, one can plan one's diet accordingly. One should also be able to plan one's acquisition, whether it is by purchases or home production. Certainly, the home food production system ought to be planned with food requirements in mind.

About 40 different nutrients are needed by the body, some in large quantities, and some in only very small amounts. The principal nutrients are mentioned below and some of their sources:

Needed in large amounts-

- **Water.** Usually available everywhere, needed not only in quantity, but in good quality.
- **Protein.** Principal building blocks of the body. Available in meat, eggs, milk, cheese, fish and grain legumes, and to a lesser extent in grains, leaves, algae, and seaweeds.
- **Fat.** Fats are indeed needed in the diet, and those that are needed are those high in non-saturated fatty acids (most plant fats), and not those high in saturated fatty acids (most animal fats and palm oils). They are

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available in pure form, in cooking oils, margarine, and butter, and are found in meats, most milk products, and many kinds of seeds and nuts, as well as a few fruits (avocados), and in hidden form in many processed food products.

- **Carbohydrates.** Sugars and starches. These are the principal fuels of the body. Sugars are easily digested and rapidly used. Starches are digested more slowly and are available to the body over a longer time. They occur in starchy vegetables and in sweet fruits, as well as in manufactured products.

- **Fiber.** Necessary for proper functioning of the digestive system. Present especially in fruits and vegetables.

Needed in small amounts-

- **Vitamins.** There are 13 to 16 necessary vitamins. (Some controversy exists.) Getting enough is often a problem. Vitamins A and C are obtained from fruits and vegetables, the B vitamins mostly associated with proteins, vitamin D from a reaction of the sun with one's skin, vitamin E from oily seeds, vitamin K is manufactured to some extent in people after eating leafy greens.

- **Minerals.** There are quite a few that are necessary, but some are much more important than others. Calcium, potassium, phosphorous, and magnesium come from milk, vegetables, and grains, as well as meats. Iron is to be had chiefly from vegetables, fruits, seaweeds, but also from red meats. Occasionally, iodine is a problem for it is lacking in some soils. It can be had from iodized salt, sea water, or foods from the sea. Zinc is now recognized as vitally important, in very small quantities. Most other minerals will be obtained easily in a normal diet.

There is another way of looking at nutrients. What are those that one finds in the foods one purchases or produces? Bread contains some protein, some B vitamins, and carbohydrates. Milk contains practically all nutrients in good proportion, but too much fat for adults. Meat and fish contain proteins, fats, and B vitamins. Eggs contain protein, B vitamins and fat. Unfortunately, they also contain high amounts of cholesterol, undesirable in excess in adult diets. Eggs laid by hens that have a diet rich in fresh greens contain less and better quality cholesterol. Grain legumes contain proteins and B vitamins and sometimes fats, and vitamin E (especially soybeans and peanuts). Cereal grains in their unpolished form contain proteins, B vitamins and E, and starch. Nuts are often good sources of protein, fats, and carbohydrates. Fruits and vegetables, especially the dark green and the yellow or orange ones, contain large amounts of vitamins A and C, as well as dietary fiber. Starchy roots and tubers contain large amounts of carbohydrates and usually vitamin C. Dark green leaves are especially good vegetables for their contents of protein, vitamins and minerals, but contain too much fiber.

As a general rule, the diet ought to contain large amounts of vegetables and fruits, somewhat lesser amounts of starchy vegetables, plenty of bread or other grain products, some good sources of protein and fat, including grain legumes, milk, etc. A varied diet with foods of many types helps to balance the nutrient intake. As a generality, Americans get too much fat in their diets, too much meat, eggs and milk, and not enough fruits and vegetables.

An outstanding food plant would combine the following characteristics:

- Be adapted to one's garden area and provide good yields of food
- Provide the nutrients most needed
- Have several other uses of value in the home and garden.

The above discussion should not be considered complete, but, indeed, an outline overview of human nutrition.

While this publication emphasizes plants for permaculture, the food production system should include farm animals as well, for their multiple purposes.

Food Crops of the Tropics for Permaculture

Cereal Grains

Common Name	Species Name	Family Name	Food Uses
Amaranth	<i>Amaranthus hypochondriacus</i>	Amaranthaceae	Dried seed, leaves.
Corn	<i>Zea mays</i>	Gramineae	Fresh, dried seed, sugar.
Kaniwa	<i>Chenopodium pallidicaule</i>	Chenopodiaceae	Dried seed, leaves.
Kiwicha	<i>Amaranthus caudatus</i>	Amaranthaceae	Dried seed, leaves.
Pearl Millet	<i>Pennisetum americanum</i>	Gramineae	Dried seed.
Quinoa	<i>Chenopodium quinoa</i>	Chenopodiaceae	Dried seed, leaves.
Rice	<i>Oryza sativa</i>	Gramineae	Dried seed.
Sorghum	<i>Sorghum bicolor</i>	Gramineae	Dried seed, sugar.
Wheat	<i>Triticum aestivum</i>	Gramineae	Dried seed.

Legumes

Common Name	Species Name	Family Name	Food Uses
Bambara Nut	<i>Voandzeia subterranea</i>	Faboideae	Dried seed, leaves.
Basul	<i>Erythrina edulis</i>	Faboideae	Fresh seed.
Common Bean	<i>Phaseolus vulgaris</i>	Faboideae	Fresh seed, dried seed.
Cowpea	<i>Vigna sesquipedalis</i>	Faboideae	Fresh, dried seed, pods.
Holosericea	<i>Acacia holosericea</i>	Mimosoideae	Ground seeds.
Horse Bean	<i>Canavalia ensiformis</i>	Faboideae	Young pod.
Inga	<i>Inga edulis</i>	Mimosoideae	Pulp of pod, seed.
Lablab Bean	<i>Dolichos lablab</i>	Faboideae	Pod, fresh, dry seed.
Lima Bean	<i>Phaseolus lunatus</i>	Faboideae	Fresh, dry seed.
Mat Bean	<i>Vigna aconitifolia</i>	Faboideae	Fresh, dried seed.
Mung Bean	<i>Vigna radiata</i>	Faboideae	Fresh, dried seed, sprout.
Nuña	<i>Phaseolus vulgaris</i>	Faboideae	Popped dry seed.
Parkia	<i>Parkia spp.</i>	Mimosoideae	Pulp and seeds.
Paterno	<i>Inga paterno</i>	Mimosoideae	Fresh seed.
Peanut	<i>Arachis hypogaea</i>	Faboideae	Fresh, dried seed.
Pigeon Pea	<i>Cajanus cajan</i>	Faboideae	Fresh, dried seed, leaves.
Rice Bean	<i>Vigna umbellata</i>	Faboideae	Fresh, dried seed.
Scarlet Runner Bean	<i>Phaseolus coccineus</i>	Faboideae	Fresh and dried seed.
Soybean	<i>Glycine max</i>	Faboideae	Fresh, dried seed.
Tarwe	<i>Lupinus mutabilis</i>	Faboideae	Fresh, dried seed.
Tepary Bean	<i>Phaseolus acutifolius</i>	Faboideae	Fresh, dried seed.
Sword Bean	<i>Canavalia gladiata</i>	Faboideae	Pod, fresh seed.
Winged Bean	<i>Psophocarpus tetragonolobus</i>	Faboideae	Pod, fresh seed, leaves.
Yeheb	<i>Cordeauxia edulis</i>	Faboideae	Fresh and dried seed.

Root Crops

Common Name	Species Name	Family Name	Food Uses
African Yam Bean	<i>Sphenostylis stenophora</i>	Faboideae	Root, fresh, dried seed.
Ahipa	<i>Pachyrhizus ahipa</i>	Faboideae	Root.
Arrowroot	<i>Maranta arundinacea</i>	Marantaceae	Rhizome.
Cassava	<i>Manihot esculenta</i>	Euphorbiaceae	Root, leaves.
Chinese Water Chestnut	<i>Eleocharis dulcis</i>	Cyperaceae	Corm.
Edible Canna	<i>Canna edulis</i>	Cannaceae	Corm.
Peruvian Carrot	<i>Arracacia xanthorrhiza</i>	Umbelliferae	Root, leaves.
Potato	<i>Solanum tuberosum</i>	Solanaceae	Tuber.
Sweet Potato	<i>Ipomoea batatas</i>	Convolvulaceae	Root, leaves.
Tannier	<i>Xanthosoma spp.</i>	Araceae	Corm, leaves.
Taro	<i>Colocasia esculenta</i>	Araceae	Corm, leaves.
Yam	<i>Dioscorea spp.</i>	Dioscoreaceae	Tuber.
Yam Bean	<i>Pachyrhizus spp.</i>	Faboideae	Root.

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Fruit Vegetables

Common Name	Species Name	Family Name	Food Uses
Bitter Gourd	<i>Momordica charantia</i>	Cucurbitaceae	Fruit, leaves.
Chayote	<i>Sechium edule</i>	Cucurbitaceae	Fruit, leaves, root.
Ground Cherry	<i>Physalis peruviana</i>	Solanaceae	Fruit.
Melons	<i>Cucumis spp, Citrullus spp</i>	Cucurbitaceae	Fruit.
Okra	<i>Abelmoschus esculentus</i>	Malvaceae	Fruit, fresh, dried seed.
Pepper	<i>Capsicum annuum</i>	Solanaceae	Fruit, leaves.
Pumpkin	<i>Cucurbita moschata</i>	Cucurbitaceae	Fruit, leaves, shoot.
Tomato	<i>Lycopersicon esculentum</i>	Solanaceae	Fruit.
Tree Tomato	<i>Cyphomandra betacea</i>	Solanaceae	Fruit.

Edible Leaves

Common Name	Species Name	Family Name	Food Uses
Amaranth	<i>Amaranthus spp.</i>	Amaranthaceae	Leaves, seeds.
Belembe	<i>Xanthosoma brasiliense</i>	Araceae	Leaves.
Cassava	<i>Manihot esculenta</i>	Euphorbiaceae	Leaves, roots.
Chaya	<i>Cnidoscolus chayamansa</i>	Euphorbiaceae	Leaves, tips.
Comfrey	<i>Symphytum officinale</i>	Boraginaceae	Leaves in tea.
Horseradish Tree	<i>Moringa oleifera</i>	Moringaceae	Leaves, flower, pod, root.
Horseradish Tree	<i>Moringa stenopetala</i>	Moringaceae	Leaves, flower, pod.
Indian Lettuce	<i>Lactuca indica</i>	Compositae	Leaves.
Indian Mustard	<i>Brassica juncea</i>	Cruciferae	Leaves.
Kangkong	<i>Ipomoea reptans</i>	Convolvulaceae	Leaves, tips.
Katuk	<i>Sauropus androgynus</i>	Euphorbiaceae	Leaves, tips.
Leucaena	<i>Leucaena leucocephala</i>	Mimosoideae	Young leaves, pods.
Nasturtium	<i>Tropaeolum majus</i>	Tropaeoaceae	Leaves, flowers.
Okinawa Spinach	<i>Gynura crepioides</i>	Compositae	Leaves.
Pacific Spinich	<i>Abelmoschus manihot</i>	Malvaceae	Leaves.
Sweet Potato	<i>Ipomoea batatas</i>	Convolvulaceae	Leaves, roots.

Other Vegetables

Common Name	Species Name	Family Name	Food Uses
Asparagus	<i>Asparagus officinalis</i>	Liliaceae	Shoots.
Bamboo	<i>Bambusa spp et al.</i>	Gramineae	Shoots.
Coconut Sprout	<i>Cocos nucifera</i>	Palmae	Root ball in seed.
Izote	<i>Yucca spp.</i>	Agavaceae	Flower.
Pacaya	<i>Chamaedorea spp.</i>	Palmae	Young inflorescence.
Palm Hearts	<i>Numerous species</i>	Palmae	Heart.
Pitpit	<i>Saccharum edulis</i>	Gramineae	Inflorescence.
Prickly Pear	<i>Opuntia spp.</i>	Cactaceae	Fruits, pads.
Sweet Corn	<i>Zea mays</i>	Gramineae	Spike of seeds.

Fruits

Common Name	Species Name	Family Name	Food Uses
Avocado	<i>Persea americana</i>	Lauraceae	Fruit.
Banana	<i>Musa spp.</i>	Musaceae	Green or mature fruit.
Breadfruit	<i>Artocarpus altilis</i>	Moraceae	Green or mature fruit.
Cacao	<i>Theobroma cacao</i>	Sterculiaceae	Fruit pulp, dried seeds.
Canistel	<i>Pouteria campechiana</i>	Sapotaceae	Fruit pulp, fresh or dry.
Citrus	<i>Citrus spp.</i>	Rutaceae	Fruit pulp.
Date	<i>Phoenix dactylifera</i>	Palmae	Fruit.
Durian	<i>Durio zibethinus</i>	Bombacaceae	Fruit, pulp, seed.
Guava	<i>Psidium guajava</i>	Myrtaceae	Fruit.
Mango	<i>Mangifera indica</i>	Anacardiaceae	Fruit, seed.
Naranjilla	<i>Solanum quitoense</i>	Solanaceae	Fruit.

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Fruits

Common Name	Species Name	Family Name	Food Uses
Papaya	<i>Carica papaya</i>	Caricaceae	Fruit, leaves.
Passion Fruit	<i>Passiflora edulis forma flavicarpa</i>	Passifloraceae	Fruit juice.
Peach Palm	<i>Guilielma gasipaes</i>	Palmae	Fruit pulp, seed.
Pineapple	<i>Ananas comosus</i>	Bromeliaceae	Fruit, heart.
Plantain	<i>Musa species</i>	Musaceae	Green or ripe fruit.

Nuts

Common Name	Species Name	Family Name	Food Uses
Breadnut	<i>Artocarpus altilis</i>	Moraceae	Seed.
Cashew	<i>Anacardium occidentale</i>	Anacardiaceae	Roasted seed, fruit.
Coconut	<i>Cocos nucifera</i>	Palmae	Green or ripe fruit.
Indian Almond	<i>Terminalia catappa</i>	Combretaceae	Seed, fruit pulp.
Joint Fir	<i>Gnetom gneton</i>	Gnetaceae	Seed, fruit pulp.
Macadamia	<i>Macadamia integrifolia</i>	Proteaceae	Seed.
Malabar Chestnut	<i>Pachira aquatica</i>	Bombacaceae	Seed, leaves, flowers.
Paradise Nut	<i>Lecythis elliptica</i>	Lecythidaceae	Seed.
Pili Nut	<i>Canarium ovatum</i>	Burseraceae	Seed, fruit pulp.
Tahitian Chestnut	<i>Inocarpus edulis</i>	Faboideae	Seed.

Other

Common Name	Species Name	Family Name	Food Uses
African Oil Palm	<i>Elaeis guineensis</i>	Palmae	Oil
Century Plants	<i>Agave spp.</i>	Agavaceae	Sap.
Owala Oil Tree	<i>Pentaclethra macrophylla</i>	Faboideae	Oil, seeds.
Shea Butter Tree	<i>Butyrospermum paradoxum</i>	Sapotaceae	Oil.
Palmyra Palm	<i>Borassus flabellifer</i>	Palmae	Sap, fruit.

Multiple Uses of Food Crops for Permaculture in the Tropics (Rated 0-5 for permaculture uses.)

Cereal Grains

Common Name	Food	Feed	Fiber	Con- struction	Fuel	Soil Amend- ment	Erosion Control	Climate Modification
Amaranth	4	2	0	0	1	1	1	0
Corn	5	5	0	1	2	1	1	0
Kaniwa	4	3	0	0	0	1	1	0
Kiwicha	4	3	0	0	0	1	1	0
Pearl Millet	4	4	0	1	1	1	1	0
Quinoa	5	0	0	0	1	1	1	0
Rice	5	3	0	0	1	1	1	0
Sorghum	4	5	0	2	2	1	1	0
Wheat	5	4	0	0	1	1	1	0

Legumes

Common Name	Food	Feed	Fiber	Con- struction	Fuel	Soil Amend- ment	Erosion Control	Climate Modification
Bambara nut	3	2	0	0	0	1	1	0
Basul	4	3	0	2	3	4	2	2
Common Bean	5	3	0	0	1	2	1	0
Cowpea	5	3	0	0	1	2	2	1
Holosericea	3	2	0	1	2	2	2	1
Horse Bean	1	3	0	0	0	2	2	1

Plants for Use in Permaculture in the Tropics

Common Name	Food	Feed	Fiber	Con- struction	Fuel	Soil Amend- ment	Erosion Control	Climate Modification
Inga	2	2	0	2	2	2	1	1
Lablab Bean	4	4	0	0	0	3	3	1
Lima Bean	4	0	0	0	0	2	1	1
Mat Bean	3	3	0	0	0	1	1	0
Mung Bean	4	2	0	0	0	1	1	0
Nuña	4	2	0	0	0	2	1	0
Parkia	2	3	0	3	3	2	1	2
Paterno	2	2	0	2	3	2	2	1
Peanut	5	4	0	0	0	3	2	0
Pigeon Pea	4	3	0	0	1	3	2	0
Rice Bean	3	1	0	0	0	1	1	0
Scarlet Runner Bean	4	1	0	0	0	1	1	1
Soybean	5	5	0	0	1	3	1	1
Sword Bean	2	2	0	0	0	2	2	1
Tarwe	3	1	0	0	0	1	1	0
Tepary Bean	3	1	0	0	0	1	1	0
Winged Bean	4	3	0	0	0	3	2	1
Yeheb	4	3	0	0	3	2	4	1

Root Crops

Common Name	Food	Feed	Fiber	Con- struction	Fuel	Soil Amend- ment	Erosion Control	Climate Modification
African Yam Bean	4	1	0	0	0	1	0	0
Ahipa	3	1	0	0	0	2	1	0
Arrowroot	3	2	0	0	0	0	1	0
Cassava	4	4	0	1	1	0	1	0
Chinese Water Chestnut	4	0	2	1	0	0	1	0
Edible Canna	2	1	0	0	0	0	1	0
Peruvian Carrot	3	2	0	0	0	0	1	0
Potato	5	3	0	0	0	0	1	0
Sweet Potato	5	5	0	0	0	0	2	0
Tannier	5	0	0	0	0	0	1	0
Taro	5	0	0	0	0	0	1	0
Yam	5	0	0	0	0	0	2	1
Yam Bean	4	1	0	0	0	1	0	0

Fruit Vegetables

Common Name	Food	Feed	Fiber	Con- struction	Fuel	Soil Amend- ment	Erosion Control	Climate Modification
Bitter Gourd	3	0	0	0	0	0	1	0
Chayote	2	1	0	0	0	0	2	1
Ground Cherry	3	1	0	0	0	0	1	0
Melons	3	1	0	0	0	0	1	0
Okra	4	1	0	0	2	0	1	0
Pepper	5	0	0	0	0	0	0	0
Pumpkin	5	3	0	0	0	0	1	1
Tomato	4	0	0	0	0	0	0	0
Tree Tomato	2	0	0	0	0	0	1	1

Plants for Use in Permaculture in the Tropics

Edible Leaves

Common Name	Food	Feed	Fiber	Construction	Fuel	Soil Amend-ment	Erosion Control	Climate Modification
Amaranth	5	1	0	0	1	0	0	0
Belembe	5	1	0	0	0	0	0	0
Cassava	5	5	0	1	1	0	1	0
Chaya	4	1	0	0	0	0	1	0
Comfrey	2	4	0	0	0	0	3	0
Horseradish Tree	5	3	0	0	1	1	2	2
Indian Lettuce	4	3	0	0	0	0	0	0
Indian Mustard	4	3	0	0	0	0	1	0
Kangkong	5	3	0	0	0	0	1	1
Katuk	5	2	0	1	0	1	1	0
Leucaena	4	4	0	2	4	4	3	2
Nasturtium	3	1	0	0	0	0	1	0
Okinawa Spinach	3	2	0	0	0	1	2	0
Pacific Spinach	5	2	0	0	0	1	1	0
Sweet Potato	5	5	0	0	0	0	3	0

Other Vegetables

Common Name	Food	Feed	Fiber	Construction	Fuel	Soil Amend-ment	Erosion Control	Climate Modification
Asparagus	4	0	0	0	0	0	2	0
Bamboo	3	2	0	4	3	0	4	4
Coconut Sprout	5	4	3	4	2	2	4	4
Izote	2	1	1	0	0	0	1	0
Pacaya	3	0	0	0	0	0	1	0
Palm Hearts	3	1	1	3	2	2	1	1
Pitpit	2	2	0	0	0	1	2	0
Prickly Pear	4	1	0	0	0	0	3	0
Sweet Corn	4	2	0	1	1	0	1	0

Fruits

Common Name	Food	Feed	Fiber	Construction	Fuel	Soil Amend-ment	Erosion Control	Climate Modification
Avocado	5	1	0	1	1	2	1	2
Banana	5	4	1	1	0	1	1	1
Breadfruit	4	3	0	1	1	1	2	2
Cacao	3	0	0	0	2	1	1	1
Canistel	4	0	0	1	2	1	1	1
Citrus	5	2	0	1	2	1	1	1
Date	5	3	0	4	3	1	1	4
Durian	3	1	0	3	3	2	1	3
Guava	5	3	0	0	3	2	1	0
Mango	5	3	0	3	3	3	1	4
Naranjilla	3	0	0	0	0	0	1	0
Papaya	5	1	0	0	0	1	1	0
Passion Fruit	4	0	0	0	0	1	2	1
Peach Palm	4	3	0	2	1	2	1	1
Pineapple	4	2	0	0	0	0	1	0
Plantain	4	3	0	0	0	0	2	0

Plants for Use in Permaculture in the Tropics

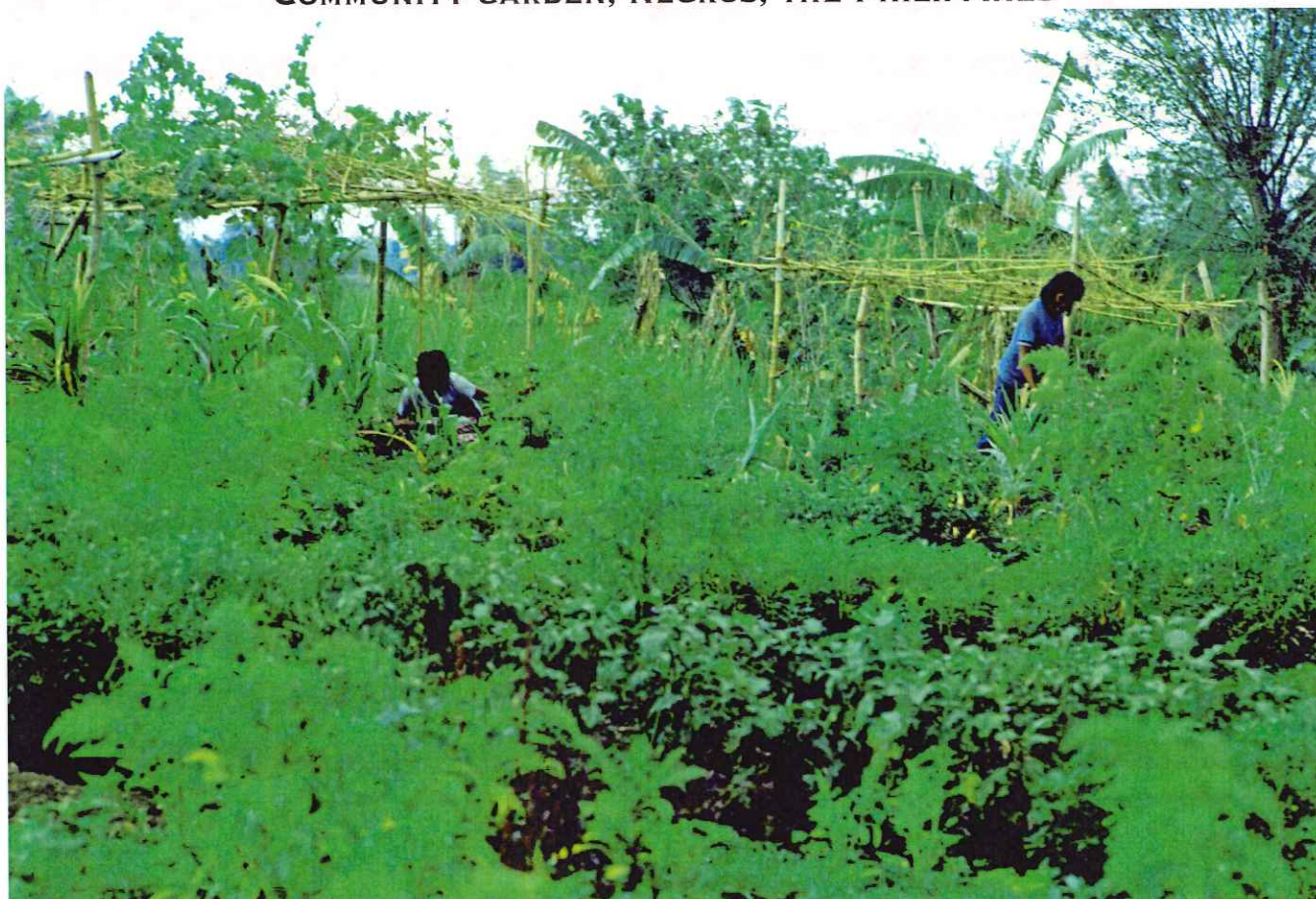
Nuts

Common Name	Food	Feed	Fiber	Con- struc- tion	Fuel	Soil Amend- ment	Erosion Control	Climate Modification
Breadnut	4	2	0	2	2	2	1	3
Cashew	4	0	0	0	0	2	3	1
Coconut	5	4	3	4	2	2	4	4
Indian Almond	3	1	0	3	3	2	1	3
Joint Fir	4	2	1	2	2	2	1	2
Macadamia	4	0	0	1	1	2	1	1
Malabar Chestnut	4	2	0	2	1	2	1	2
Paradise Nut	3	0	0	1	1	1	1	1
Pili Nut	4	3	0	2	2	2	1	2
Tahitian Chestnut	3	2	0	2	2	3	1	2

Other

Common Name	Food	Feed	Fiber	Con- struc- tion	Fuel	Soil Amend- ment	Erosion Control	Climate Modification
African Oil Palm	4	2	2	3	2	2	1	3
Century Plants	3	0	4	1	0	1	2	1
Owla Oil Tree	4	2	0	2	4	2	1	2
Shea Butter Tree	4	0	0	1	2	2	2	1
Palmyra Pam	3	0	2	3	1	1	2	3

COMMUNITY GARDEN, NEGROS, THE PHILIPPINES



Supplemental Plants and Their Multiple Uses

Supplemental plants, as defined here, are those plants not used directly as food, but whose principal use is nevertheless closely related to the needs of people. Some of the species included here as supplemental plants also have minor food uses. If they had important food uses, however, they would have been classified as food plants,

The most important of the supplemental plants are those that are used as feed for farm animals, especially those used for meat, milk, and egg production. Most feed plants are grasses or legumes. Grasses are often easy to grow in almost pure stands, can often thrive under dry or infertile conditions, utilizing lands not very suitable for other crops. Legumes in the tropics are poor competitors of grasses and are difficult to establish in mixed pastures, but they are important for the protein they contribute to animals. In spite of this incompatibility, legumes continue to be grown with grasses. Many other plants are eaten as browse, occasionally eaten plants, and may be very important in an animal's diet.

Fiber plants are those that produce strong and long fibers that can be used to produce string and thus rope, nets, and, of course, cloth. Cloth is produced not only by weaving, but by beating, yielding a cloth such as tapa, similar in many ways to felt.

Every tree produces wood, but timber is the production of useful lengths of wood for our purposes, especially for the construction of homes and other structures (boats). Wood is also used as posts, for many wooden articles, and for carvings, useful and ornamental. Wood can also be used as pulp and formed into paper, or as chips formed into boards, but these processes may not be suitable for the small farm.

Almost any wood can be used as fuel, but the characteristics of wood fuel vary tremendously. The best woods for sustained heating are dense and burn hot over a long period of time. They may not be appropriate for cooking in the summer. Light, fast burning woods, and even woody stems of weeds, are very suitable for rapid cooking or boiling. Such light density woods are very common and easy to obtain. Frequently, the most convenient fuel is that from wood grown on the farm for other purposes. The trees suitable for fuel wood vary among different regions of the tropics.

While some might consider supplemental plants to be inferior to food-producing plants, the complementary nature of the two kinds of plants must be recognized.

Although some of the species listed as supplemental plants have been previously recognized as food plants, the double classification should only serve as an emphasis of their values.

Please note that some of these species may be aggressive and weedy, reasons for great care when introducing and testing.

Multiple Uses of Plants Used as Feed

Feed Legumes

Common Name	Species Name	Family	Food	Feed	Fiber	Con- struction	Fuel	Soil Amend- ment	Erosion Control
Apple Ring Acacia	<i>Acacia albida</i>	<i>Mimosoideae</i>	0	5	0	3	3	4	3
Centro	<i>Centrosema pubescens</i>	<i>Faboideae</i>	0	4	0	0	0	4	4
Jack Bean	<i>Canavalia ensiformis</i>	<i>Faboideae</i>	1	3	0	0	0	2	2
Jerusalem Thorn	<i>Parkinsonia aculeata</i>	<i>Caesalpinioideae</i>	3	3	0	1	4	3	3
Kudzu	<i>Pueraria phaseoloides</i>	<i>Faboideae</i>	0	4	0	0	0	3	4
Leucaena	<i>Leucaena leucocephala</i>	<i>Mimosoideae</i>	4	4	0	2	4	4	3
Mesquite	<i>Prosopis spp.</i>	<i>Mimosoideae</i>	2	5	0	3	4	3	4
Mother of Cacao	<i>Gliricidia sepium</i>	<i>Faboideae</i>	2	3	0	3	3	3	3
Prickly Sesban	<i>Sesbania bispinosa</i>	<i>Faboideae</i>	2	3	0	3	3	3	3
Spanish Clover	<i>Desmodium uncinatum</i>	<i>Faboideae</i>	0	4	0	0	0	4	4
St. John's Bread	<i>Ceratonia siliqua</i>	<i>Caesalpinioideae</i>	4	5	0	2	4	2	2
Umbrella Thorn	<i>Acacia tortilis</i>	<i>Mimosoideae</i>	0	4	0	4	4	4	4

Feed Grasses

Common Name	Species name	Family	Food	Feed	Fiber	Con- struction	Fuel	Soil Amend- ment	Erosion Control
Bermuda	<i>Cynodon dactylon</i>	<i>Gramineae</i>	0	5	0	0	0	0	4
Guinea	<i>Panicum maximum</i>	<i>Gramineae</i>	0	4	0	1	0	0	2
Kikuyu	<i>Pennisetum clandestinum</i>	<i>Gramineae</i>	0	5	0	0	0	0	4

Plants for Use in Permaculture in the Tropics

Common Name	Species name	Family	Food	Feed	Fiber	Con- struc- tion	Fuel	Soil Amend- ment	Erosion Control
Napier	<i>Pennisetum purpureum</i>	Gramineae	0	5	0	2	1	0	4
Pangola	<i>Digitaria decumbens</i>	Gramineae	0	5	0	0	0	0	4
Star	<i>Cynodon nlemfluensis</i>	Gramineae	0	5	0	0	0	0	4
Sudan	<i>Sorghum sudanense</i>	Gramineae	0	5	0	2	1	0	1

Multiple Uses of Supplemental Plants

Fiber Plants

Common Name	Species name	Family	Food	Feed	Fiber	Con- struc- tion	Fuel	Soil Amend- ment	Erosion Control
Abaca	<i>Musa textilis</i>	Musaceae	0	0	2	0	0	0	1
Cotton	<i>Gossypium spp.</i>	Malvaceae	3	3	5	0	2	0	1
Hemp	<i>Cannabis sativa</i>	Cannabaceae	1	0	1	0	0	0	1
Jute	<i>Corchorus capsularis</i>	Tiliaceae	2	1	3	1	0	0	0
Kapok	<i>Ceiba pentandra</i>	Bombacaceae	2	1	2	1	2	0	0
Kenaf	<i>Hibiscus cannabinus</i>	Malvaceae	1	1	2	0	0	0	1
Mahoe	<i>Hibiscus tiliaceus</i>	Malvaceae	2	1	2	1	2	0	0
Ramie	<i>Boehmeria nivea</i>	Urticaceae	1	1	3	0	1	0	1
Sisal	<i>Agave et al.</i>	Agavaceae	1	0	2	0	0	0	1

Timber Plants

Common Name	Species name	Family	Food	Feed	Con- struc- tion	Fuel	Soil Amen- d-ment	Erosion Control	Other
Fromorsia	<i>Pericopsis elata</i>	Faboideae	0	0	0	5	5	4	2
Bamboo	<i>Bambusa et al.</i>	Gramineae	2	2	0	4	3	0	4
Intsia	<i>Intsia spp.</i>	Faboideae	0	0	0	5	5	4	2
Mahogany	<i>Swietenia mahagoni</i>	Meliaceae	0	0	0	5	4	0	2
Monkey Pod	<i>Samanea saman</i>	Mimosoideae	1	3	0	4	4	2	1
Narra	<i>Pterocarpus indicus</i>	Faboideae	0	0	0	4	4	4	2
Rosewood	<i>Dalbergia sp</i>	Faboideae	0	0	0	3	4	3	2
Teak	<i>Tectona grandis</i>	Verbenaceae	0	0	0	5	4	0	2
Tropical Pines	<i>Pinus spp.</i>	Pinaceae	0	0	0	5	5	1	2

Fuel Wood Trees of the Hot, Humid Tropics

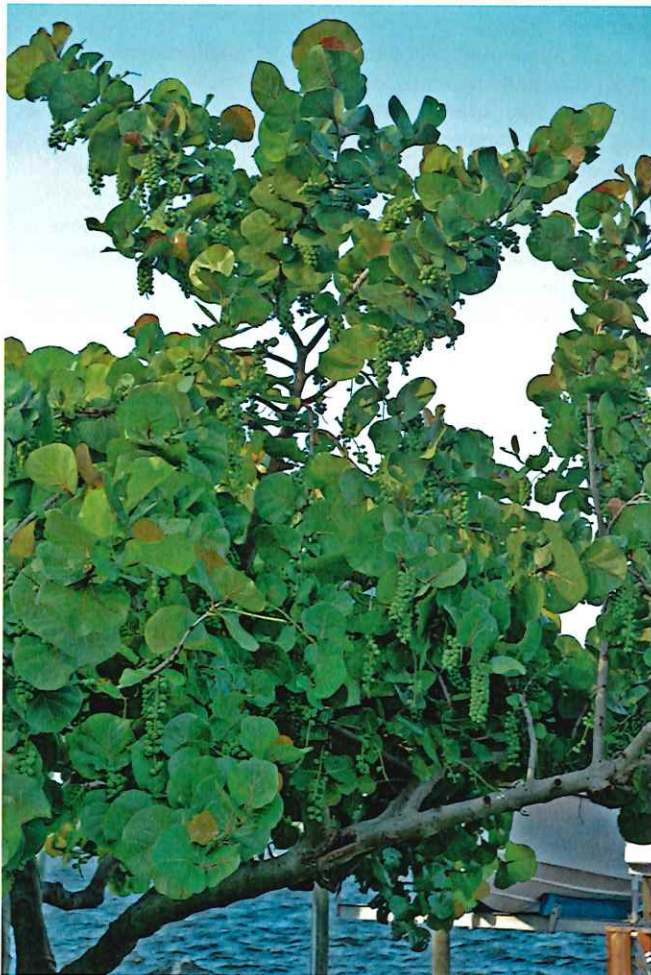
Common Name	Species name	Family	Food	Feed	Con- struc- tion	Fuel	Soil Amend- ment	Erosion Control	Other
Ear Acacia	<i>Acacia auriculiformis</i>	Mimosoideae	0	0	1	4	4	1	Pulp
Agati	<i>Sesbania grandiflora</i>	Faboideae	2	4	1	4	4	4	Pulp
Ampupu	<i>Eucalyptus urophylla</i>	Myrtaceae	0	0	3	4	1	1	
Batau	<i>Albizia falcata</i>	Mimosoideae	0	0	3	4	5	5	Pulp
Bracatinga	<i>Mimosa scabrella</i>	Mimosoideae	1	1	1	4	4	4	Pulp
Calliandra	<i>Calliandra calothyrsus</i>	Mimosoideae	0	5	2	5	5	5	Honey
Capulin	<i>Muntingia calabura</i>	Elaeocarpaceae	1	0	0	3	3	1	
Casuarina	<i>Casuarina equisetifolia</i>	Casuarinaceae	0	0	4	5	1	4	Pulp
Derris	<i>Derris indica</i>	Faboideae	0	3	3	5	5	1	Insecticide
Gmelina	<i>Gmelina aborea</i>	Verbenaceae	0	0	3	4	1	2	Honey
Guacima	<i>Guazuma ulmifolia</i>	Sterculiaceae	3	3	3	4	1	2	
Guava	<i>Psidium guajava</i>	Myrtaceae	5	4	3	5	1	1	

Plants for Use in Permaculture in the Tropics

Fuel Wood Trees of the Hot, Humid Tropics

Common Name	Species name	Family	Food	Feed	Con- struc- tion	Fuel	Soil Amend- ment	Erosion Control	Other
Gumbolimbo	<i>Bursera simaruba</i>	Burseraceae	0	0	2	4	1	1	Fence
Honduras Pine	<i>Pinus caribaea</i>	Pinaceae	0	0	5	4	1	3	
Kamarere	<i>Eucalyptus deglupta</i>	Myrtaceae	0	0	4	4	1	1	Beauty
Leucaena	<i>Leucaena leucacephala</i>	Mimosoideae	3	5	2	3	5	4	
Mahoe	<i>Hibiscus tiliaceus</i>	Malvaceae	2	0	3	3	1	3	
Mother of Cacao	<i>Gliricidia sepium</i>	Faboideae	2	4	3	4	5	4	Fence
Musizi	<i>Maesopsis emini</i>	Euphorbiaceae	1	2	3	4	1	1	
Prickly Sesban	<i>Sesbania bispinosa</i>	Faboideae	0	2	4	1	4	4	Gum
Red Gum	<i>Eucalyptus robusta</i>	Myrtaceae	0	0	4	4	1	1	
Red Mahogany	<i>Eucalyptus pellita</i>	Myrtaceae	0	0	5	4	1	1	
Sea Grape	<i>Coccoloba uvivera</i>	Polygonaceae	2	0	3	5	1	3	Beauty

SEA GRAPES



Plants for Ecological Purposes

In a way, every plant is useful to the ecology, and no one species is more valuable than another. In still another sense, plants are valuable to the extent that they protect Earth as our home and the source of sustenance for our survival or supplemental products for humankind. It is in this latter sense that the term, "Plants for Ecological Purposes," is used here. Unfortunately, in spite of their importance, little attention has been given to plants for ecological purposes, when one compares them to plants that produce food. Therefore, judgments of the relative value of such plants are made more difficult by our very ignorance.

There are numerous ways that plants are used for ecological purposes, but these can be classified in a few categories:

- Those that change the microclimate-
 - by shade,
 - by "attracting" condensation of water,
 - by breaking the force of winds;
- Plants that protect and enrich the soil-
 - by fixing nitrogen,
 - by the deposition and accumulation of organic material,
 - by bringing up minerals from the depths of the soil and depositing them in leaves that fall to the surface;
- Plants that reduce soil erosion-
 - by breaking the force of rain on the soil surface,
 - by holding soil with an extensive root system,
 - by making a physical barrier to runoff,
 - by taking up and transpiring excess water;
- Plants that encourage animals by providing food and shelter.

Only a few of the many plants that are useful ecologically are mentioned here.

Alley cropping is a system of agricultural production especially useful for sloping land where rows of small trees are planted along the contours of the area where they act as a physical barrier to erosion, contribute minerals and organic material through leaf fall, and may serve as a source of food, feed, firewood, construction materials, or other useful products. A relatively few species have proved so far to be highly useful for such systems. Ground covers are those plants particularly useful to avoid erosion by growing a thick cap of vegetation to cover the soil, and which also tend to smother weeds. While any plant can be a ground cover, there are a few very efficient ones.

Windbreaks are trees used to break the force of the winds, and thus to protect agricultural crops. The value of a windbreak is positively related to its height and negatively related to its width. Tall, narrow trees that also provide other benefits are particularly useful. A good windbreak might consist of several species of plants at different heights. Living fences consist of conventional posts of living trees strung with wire, or closely planted trees that act as a barrier. The phrase "living fence" is usually restricted to those trees that can be planted from large cuttings. The individual trees may serve many other purposes as well.

Especially worthy of mention here are the nitrogen-fixing trees, principally legumes, many of which, by nature, in cooperation with a bacterium, add useful nitrogen to the soil.

As a rule, in searching for plants for ecological purposes, one wishes to find a plant with multiple purposes.

Multiple Uses of Plants for Ecological Purposes

Alley Cropping

Common Name	Species Name	Family Name	Alley Crop	Nit. Fix	Ground Cover	Eros. Cont.	Mulch	Wind Break	Shade
Agati	<i>Sesbania grandiflora</i>	Faboideae	5	3	0	4	2	1	1
Coral bean	<i>Erythrina berteroana</i>	Faboideae	4	5	0	3	2	1	1
Flemingia	<i>Flemingia macrophylla</i>	Faboideae	4	4	0	4	4	0	0
Leucaena	<i>Leucaena leucocephala</i>	Mimosoideae	5	5	0	2	3	1	1
Mother of Cacao	<i>Gliricidia sepium</i>	Faboideae	4	4	1	2	3	1	3
Pigeon Pea	<i>Cajanus cajan</i>	Faboideae	5	4	3	3	3	0	0
Tagasaste	<i>Chamaecytisus palmensis</i>	Faboideae	5	4	1	2	3	0	0

Plants for Use in Permaculture in the Tropics

Ground Cover

Common Name	Species Name	Family Name	Alley Crop	Nit. Fix	Ground Cover	Eros. Cont.	Mulch	Wind Break	Shade
Desmodium	<i>Desmodium spp.</i>	Faboideae	0	4	3-5	3-5	3	0	0
Indigo	<i>Indigofera spp.</i>	Faboideae	0	4	5	5	3	0	0
Jack Bean	<i>Canavalia ensiformis</i>	Faboideae	0	4	4	3	3	0	0
Kudzu	<i>Pueraria phaseoloides</i>	Faboideae	0	4	5	5	2	0	0
Lablab Bean	<i>Dolichos lablab</i>	Faboideae	0	4	1-5	1-5	2	0	1
Velvet Bean	<i>Stizolobium deeringianum</i>	Faboideae	0	4	5	5	3	0	0

Windbreak

Common Name	Species Name	Family Name	Alley Crop	Nit. Fix	Ground Cover	Eros. Cont.	Mulch	Wind Break	Shade
Casuarina	<i>Casuarina spp.</i>	Casuarinaceae	0	2	0	3	4	5	4
Eucalyptus	<i>Eucalyptus spp.</i>	Myrtaceae	0	0	0	2	4	5	5
Tamarisk	<i>Tamarix spp.</i>	Tamaricaceae	0	0	0	4	4	5	4

Living Fence

Common Name	Species Name	Family Name	Alley Crop	Nit. Fix	Ground Cover	Eros. Cont.	Mulch	Wind Break	Shade
Babul Acacia	<i>Acacia nilotica</i>	Mimosoideae	3	4	0	3	1	1	1
Basul	<i>Erythrina edulis</i>	Faboideae	1	4	0	2	2	2	2
Bulbstem Yucca	<i>Yucca elephantipes</i>	Agavaceae	1	0	0	2	0	0	0
Coral Bean	<i>Erythrina berteroana</i>	Faboideae	4	5	0	3	2	1	1
Dracaena	<i>Dracaena fragrans</i>	Agavaceae	0	0	1	0	1	0	1
Gumbolimbo	<i>Bursera simaruba</i>	Burseraceae	1	0	0	1	1	1	1
Mahoe, Hau	<i>Hibiscus tiliaceus</i>	Malvaceae	1	0	0	3	2	3	3
Mother of Cacao	<i>Gliricidia sepium</i>	Faboideae	3	4	0	3	3	0	2
Pencil Euphorbia	<i>Euphorbia tirucalli</i>	Euphorbiaceae	0	0	0	2	1	0	0
Tree Tobacco	<i>Achillea arborescens</i>	Solanaceae	1	0	0	1	1	1	0

GUMBO LIMBO



Permaculture Plant Facts Sheets

The most useful multiple-purpose plants for the small farm may be those that are listed below. Each is treated in the following pages with more information. An attempt has been made to include species of many types, as would be desirable on a small farm. Note that many of the species included here could be replaced with others of the same category (see tables).

African Breadfruit	Lablab Bean
Agati	Leucaena
Agave	Mahoe, Hau
Apple-ring Acacia	Malabar Chestnut
Australian Pine	Mango
Avocado	Mother of Cocoa
Bamboo	Neem
Banana	Okra
Basul	Owala Oil Tree
Breadfruit	Palmyra Palm
Breadnut	Pangola Grass
Calabash	Papaya
Carob	Paradise Tree
Coconut	Parkia
Coral Bean	Peanut
Corn	Pigeon Pea
Cowpea	Pilnut
Date Palm	Prickly Pear
Elephant Grass, Napier	Prickly Sesban
Florida Velvet Bean	Prosopis
Guava	Shea Butter Tree
Guinea Grass	Soybean
Gumbolimbo	Sweet Potato
Holosericea	Tahitian Chestnut
Honeylocust	Tamarind
Horseradish Trees	Taro
Indian Almond	Tropical Lima Bean
Jack Bean	Tropical Pumpkin
Jackfruit	Umbrella Thorn
Jerusalem Thorn	Winged Bean
Katuk	Yams
Kudzu	Yeheb

African Breadfruit

Names: *Treculia africana*, African Breadfruit.

Principal use: The seed is a versatile food.

Brief description: A large tree of the family Moraceae.

Climatic adaptation: Adapted to the hot, humid tropics.

Yields: Food: Seeds are roasted or boiled, then peeled and eaten. The seeds are also ground into a flour used in soups, drinks, etc. The pulp of the fruit is also edible. Edible oil is extracted from the seeds.

Feed: The foliage is used as fodder.

Other products: The oil is used for many purposes.

Plants for Use in Permaculture in the Tropics

African Breadfruit, cont...

Suitability for Special Purposes:

Hedge: Used as a tall hedge.

Windbreak: Makes an effective windbreak.

Shade: Attractive shade tree.

Erosion control: Fast-growing, useful for soil conservation, source of mulch.

Lumber: The wood is soft, used for carving and for pulp.

Fuel: Makes a fast-burning fuel.

Culture: Planted from seeds or cuttings.

Other: Seeds of other *Treculia* species are also edible.

Agati

Names: *Sesbania grandiflora*, agati.

Principal use: Flowers and young pods as vegetables.

Brief description: Rapidly growing, small leguminous tree with compound leaves, small leaflets, large and attractive flowers, followed by long narrow pods.

Climatic adaptation: Hot, somewhat dry tropics.

Yields: Food: The flowers and young pods as vegetables, the young leaves cooked as spinach.

Feed: The leaves and pods as forage.

Other products: Pulpwood for paper, source of a useful gum, tannins for curing hides.

Suitability for special purposes:

Hedge: Can be trimmed as a hedge.

Living trellis: Because of the open foliage, makes a good living trellis.

Shade: The gentle shade is useful for some crops.

Alley cropping: A useful tree in alley cropping.

Nitrogen fixation: Yes.

Fuel: A fast-burning fuel.

Culture: Planted from seeds in permanent locations. Avoid flooding and heavy soils.

Special problems: The pods are often attacked by insects.

Toxic characteristics: The seeds are poisonous. Other plant parts may be slightly poisonous.

Other: Trees tend to be short-lived.

Agave

Names: *Agave* species as follows: agave, century plant, maguey.

Principal use: The sap or the extracted sugars in making drinks.

Brief description: Large, succulent plants with long lanceolate leaves radiating from a thick base, terminating growth with a tall flowering stock which bears flowers and pods or preformed plantlets.

Climatic adaptation: Adapted to the hot, dry, temperate-to-tropical climates, to sandy soil, and often to alkali and salt.

Yields: The useful products vary according to species.

Food: 1: Flowers or inflorescence cooked. 2: Base or plant body roasted. 3: Sap used fresh. 4: Sap fermented and then sometimes distilled. 5: Plant body roasted, sugars extracted, fermented and distilled.

Other products: 6: Fibers extracted and used for many purposes, some famous throughout the world.

Principal species and their uses: *Agave americana*: 1, 2, 3, 4. *A. asperrima*: 3. *A. atrovirens*: 1, 4. *A. cantala*: 6. *A. complicata*: 3, 4, 5. *A. crassispina*: 4. *A. deserti*: 2. *A. falcata*: 6. *A. fourcroydes* (henequen): 6. *A. funkiana*: 6. *A. gracilispina*: 4, 6. *A. kirchneriana*: 4, 6. *A. lecheguilla*: 6. *A. letonae*: 6. *A. lophantha*: 6. *A. mapisaga*: 4. *A. melliflua*: 3, 4. *A. parryi*: 1. *A. salmiana*: 1. *A. shawii*: 1. *A. sisalana* (sisal hemp): 4, 5, 6. *A. tequilana*: 5. *A. utahensis*: 1, 2. *A. virginica*: medicinal. *A. victoria-reginae*: 6, ornamental. *A. weberi*: 3, 6. *A. xylonacantha*: 6. *A. zazupe*: 6.

Suitability for other purposes:

Hedge: Often planted as a barrier hedge in place of a fence.

Erosion control: Some types, particularly those that produce large numbers of plantlets, are very suitable for fast growth on unstable land.

Animal shelter: A welcome shelter for birds and small animals.

Culture: Propagated by seed, by offshoots, and by plantlets, according to species. Each use requires specific techniques.

Toxic characteristics: Handling of cut parts can cause dermatitis. The juice in the eye can be dangerous.

Other: Some of these species are of great economic importance.

Plants for Use in Permaculture in the Tropics

Apple- Ring Acacia

Names: *Acacia albida*, apple-ring acacia, ana tree.

Principal use: Forage tree for dry, desert areas.

Brief description: A small, leguminous tree.

Climatic adaptation: Adapted to very dry desert areas, withstanding drought and sun.

Yields: Feed: Twigs and small branches are foraged by animals year round, and the pods make good forage in the driest season.

Other Products: A source of gum Arabic.

Suitability for special purposes:

Living Fence: A potential use.

Hedge: A possible use where few other hedge plants exist.

Shade: Welcome shade where little exists.

Erosion control: Excellent for conditions of the desert.

Alley cropping: Needs trial as a potential species.

Animal shelter: Yes, under desert conditions.

Nitrogen fixation: Yes, excellent.

Lumber: Of little value as lumber.

Fuel: A very good source of fuel under desert conditions.

Culture: Seeds may need scarification. Trees can be established in pots for later planting in the field. Needs little care once established.

Toxic characteristics: Pods are used as fish poison; may be somewhat toxic when used in quantity. Many medicinal uses, including against diarrhea.

Other: The bark is used in tanning hides. A flat piece of the wood is used in creating a fire.

Australian Pine

Perhaps the Best Windbreak in the Tropics.

Names: *Casuarina spp.*, Australian pine, beefwood, ironwood.

Principal use: A rapidly growing windbreak.

Brief description: Tall, narrow, conifer-like tree, with long leaves like needles, but jointed, and with small cones.

Climatic adaptation: Widely adapted in the tropics and subtropics, salt and wind resistant.

Yields: Other products: Wood is valuable as lumber and makes an excellent fuel.

Suitability for special purposes:

Hedge: Can be pruned as a hedge to any height desired.

Barrier plant: An excellent barrier plant.

Living trellis: Suitable as a living trellis.

Windbreak: Excellent.

Shade: The shade is not dense.

Erosion control: Excellent tree to hold the soil, combined with smaller plants. Its thick coat of old leaves makes a lasting mulch.

Earthworks: Excellent in earthworks.

Animal shelter: Animals find shelter in the hedges and dense clumps of this species.

Nitrogen fixation: Believed to fix nitrogen.

Lumber: Very good timber tree.

Fuel: One of the best and most easily-grown high-density fuels of the tropics.

Culture: Planted from seeds, once established it grows rapidly.

Special problems. Can be a weedy tree. Needs control.

Other: The accumulated leaves make excellent garden mulch.

Avocado

Names: *Persea americana*, avocado.

Justification for inclusion here: Although not a multiple-purpose tree, avocado is an easy fruit to produce and of high nutritional value, useful on any small tropical farm or any permaculture system.

Principal use: A fresh fruit high in oil content.

Brief description: Small to large, rapidly growing tree with ovate to elliptic leaves, inconspicuous yellowish green flowers in clusters, and spherical to pear-shaped fruits, each with one large seed.

Plants for Use in Permaculture in the Tropics

Avocado, cont....

Climatic adaptation: The original three races of avocados have been highly selected and hybridized, thus developing varieties suitable for most climates. Needs dry weather during flowering; prefers moderate temperatures and rainfall.

Yields: Food: The fully ripe fruit eaten out of hand, or in salads, sauces, or even ice cream. The extracted oil for cooking.

Feed: The ripe fruits make good pig and chicken food.

Other products: The extracted oil can be used for a number of purposes, chiefly cosmetic.

Suitability for special purposes:

Shade: A good ornamental and shade tree in the yard.

Lumber: The wood is soft and makes poor lumber.

Fuel: Fallen branches make fast-burning fuel.

Culture: Planted from seeds. The seedlings can be grafted with superior varieties tested for any particular location. It is difficult to judge maturity. Often the fruit will begin to fall, and at this time they can all be picked. In other varieties, trial pickings are necessary to see if the fruit will ripen in a few days.

Special Problems: Very susceptible to a disease of the soil, which kills mature trees and may make production impossible in some regions.

Toxic characteristics: All parts of the plant except the fruit are toxic, especially to animals.

Other: The fruits and other plant parts have many medicinal uses.

Bamboo

Names: *Bambusa spp.* and related genera, all easily recognized as bamboo.

Principal use: A wooden material for construction purposes.

Brief description: Large grasses with woody culms that can be very long and strong, with relatively small, spindle-shaped leaves, rarely producing grass-like flowers.

Climatic adaptation: Widely adapted throughout the tropics, including the hot and humid tropics.

Yields: Food: The young shoots are eaten as a vegetable.

Feed: Used as occasional forage.

Other products: The culms are harvested as timber, used as poles in construction and flattened to provide planks for floors and walls, or split into long, narrow pieces and woven into mats or other articles. The long culms are used as pipes and water troughs, and are carved into small articles.

Suitability for special purposes:

Living fence: Some species make excellent living fences.

Hedge: Can be used for relatively large hedges.

Barrier plant: Dense stands of bamboo are very effective barriers.

Windbreak: Very good windbreaks.

Erosion control: Often used to control erosion on hillsides. The fallen leaves make good mulch.

Lumber: As previously mentioned, a good lumber substitute.

Fuel: Can be used as fuel. Culm pieces with unbroken nodes can explode.

Culture: Normally planted from side shoots that are often removed with great labor. In some species, the culm can be buried and will sprout, or the culm can be set as a post and will sprout. Seeds are rarely produced, but germinate well.

Special problems: Bamboos can become weedy. [But not *Bambusa spp.* – Ed.] Old plantings may be difficult to remove.

Other: A very useful plant in many parts of the tropics.

Banana

An especially valuable plant for the small farm in the tropics.

Names: *Musa spp.*, the taxonomy is complex, bananas and plantains.

Principal use: A starchy food cooked or uncooked.

Brief description: Tall herbaceous stems rising from an underground rhizome, bearing large inflorescences and finger-like fruits.

Climatic adaptation: Adapted to the hot humid tropics, varieties differ in their tolerance of drought and cold.

Yields: Food: The unripe fruit cooked in several ways; the ripe fruit eaten out of hand or cooked, or used as a mash in baked products, dried and ground as a flour, extracted for starch, fermented to alcohol. Parts of the stem and of the inflorescence, and even of the rhizome are used as food in the case of some varieties.

Feed: Green and ripe fruits as well as discarded stems are used as feed.

Other products: Leaves are used for wrapping objects and as sources of fiber.

Plants for Use in Permaculture in the Tropics

Banana, cont....

Suitability for special purposes:

Hedge: Makes a rapidly growing but ever-changing hedge.

Erosion control: Can be a useful barrier to erosion.

Alley cropping: Sometimes used in alley cropping.

Animal shelter: Shelter for snakes and rats.

Culture: Propagated from clump offshoots. The taller shoots with thick stems and narrow leaves should be selected and removed with machete or mattock. Responds to heavy fertilization and adequate water. The stem is cut near ground level when racemes of fruits are harvested.

Special problems: Bananas have their specific diseases and a few pests that are often important locally.

Basul

Names: *Erythrina edulis*, basul.

Principal use: Seeds are boiled as a useful pulse.

Brief description: Medium-sized, spreading tree bearing clusters of flowers followed by large, fat pods.

Basul, cont....

Climatic adaptation: Adapted to medium altitudes of the tropics.

Yields: Food: The seeds of the green, immature pod are removed and boiled. The very young leaves may be eaten as spinach.

Feed: The foliage is given to animals as cut feed.

Suitability for special purposes:

Living fence: Can be planted from large stakes to make a living fence.

Living trellis: A suitable plant for a living trellis for upland vine crops.

Windbreak: Can be used as a windbreak.

Shade: A good tree for shade in pastures or in streets or yards.

Nitrogen fixation: Fixes nitrogen.

Lumber: Suitable source of a fair grade of lumber, or for carving objects.

Fuel: The wood is soft and usable as a fair quality fuel.

Culture: Planted from stakes or from seed. Seldom given further attention, except pruning when used in fences or pastures.

Toxic characteristics: Most Erythrinins are somewhat to very toxic, and thus this tree should be considered potentially dangerous as food or feed.

Breadfruit

Names: *Artocarpus altilis*, breadfruit. See also: Breadnut.

Principal use: As a starchy staple food.

Brief description: Tall tree with large, deeply-lobed leaves producing a thick spike as a flower, followed by a large, almost spherical fruit.

Climatic adaptation: Widely adapted in the tropics, to light and heavy soil, beach to high elevations, low to heavy rainfalls.

Yields: Food: The immature fruit, cooked as a starchy vegetable, or beaten into a batter and fried. The ripe fruit cooked as a dessert dish. The fruit fermented to produce a lasting product, or dried and ground into flour.

Feed: The raw and cooked fruits make excellent feeds.

Suitability for special purposes:

Windbreak: If closely planted, makes a good windbreak.

Shade: Excellent shade, but dangerous when fruits are falling.

Lumber: The wood is soft and useful for carving.

Fuel: Makes an inferior fuel.

Culture: Propagated from spontaneous shoots from the roots. These need careful handling until the new tree is established. Rapid growth, benefits from weed control and fertilization. Large trees should be pruned back severely periodically.

Special problems: The tree tends to produce a large amount at one season, and nothing at other seasons.

Other: One of the most easily produced staple foods of the tropics.

Plants for Use in Permaculture in the Tropics

Breadnut

Names: *Artocarpus altilis*, breadnut (seedy forms of breadfruit.)

Principal use: Seeds cooked like chestnuts.

Brief description: Small to large tree growing rapidly from seed, with very large, lobed leaves, soft and easily broken branches, an unusual yellowish-green flower, large spherical fruit filled with large seeds in a soft pulp.

Climatic adaptation: Strictly tropical, adapted to a wide range of soils, prefers abundant rainfall.

Yields: Food: The unripe fruit can be cooked as a vegetable. The ripe fruits fall to the ground where the seeds are collected. They are boiled or roasted and are high in carbohydrates, moderate in protein and fat.

Feed: The fruits are eaten by pigs.

Suitability for special purposes:

Windbreak: A rapidly growing and effective windbreak.

Shade: Useful for short-lived shade.

Culture: Planted from fresh seeds, which germinate readily. No special care is given except protection from animals. Growth is rapid and production is expected in about three years.

Other: The milky latex is used as a glue substitute.

Calabash

Names: *Crescentia cujete*, calabash.

Principal use: The shell of the hard fruit for making utensils.

Brief description: Small, spreading tree with hard-shelled baseball to watermelon sized fruits closely attached to the trunk.

Climatic adaptation: Widely adapted to the tropics, especially suitable for monsoon climates, and can tolerate a long dry season.

Yields: Food: The young leaves, cooked as spinach; the seeds, ground and cooked or mixed into drinks.

Feed: The leaves as forage, the fruits are broken open by cattle and the pulp is eaten.

Other products: The hard shell is used as containers, drinking cups, or other dishes.

Suitability for special purposes:

Hedge: Can be effectively used as a hedge in dry regions.

Shade: In dry areas with few trees, the shade is welcome.

Lumber: The wood is hard and useful, but available only in short lengths.

Fuel: Good quality firewood.

Culture: The trees are grown from seed. The young seedlings need care and protection from animals until of sufficient size.

Toxic characteristics: The pulp of the fruit is very acid. It is purgative and has caused abortion.

Other: Many medicinal uses.

Carob

Names: *Ceratonia siliqua*, carob, St. John's bread.

Principal use: Dried pulp around seed used as food or feed.

Brief description: Small to medium-sized leguminous tree with pinnately compound leaves, leaflets thick and leathery, pods 8-30 cm with several seeds in a sweet pulp.

Climatic adaptation: Hot, dry subtropics. Withstands some freezing. Does not tolerate excess water.

Yields: Food: The pulp is eaten out of hand, stored until needed, and made into many products.

Feed: Whole pods are used as fodder. The pods, after extraction of the pulp, are also used as feed.

Other products: A gum from the pulp is used in food and industrial products.

Suitability for special purposes:

Hedge: Can be used as a hedge, needs pruning.

Shade: Large trees make welcome desert shade.

Erosion control and reforestation: An excellent species.

Nitrogen fixation: Useful, also for retrieval of deep nutrients.

Lumber: Of limited use.

Fuel: Useful fuel.

Culture: Seeds need treatment in boiling water to germinate readily. Slow growing at first, but deep rooted and persistent, can grow fast when conditions are appropriate. Trees may be grafted with superior varieties.

Other: Trees from seed are either female and need a pollinator, hermaphroditic, or male.

Plants for Use in Permaculture in the Tropics

Coconut

An especially valuable plant for the small farm in the tropics.

Names: *Cocos nucifera*, coconut.

Principal use: The edible nut for its numerous uses.

Brief description: Tall palm with pinnately feathered fronds, clusters of small whitish flowers, and large nuts with a thick husk.

Climatic adaptation: Adapted to the hot, humid tropics and especially to coastal regions, but also found inland and upland.

Yields: Food: The young growing tip as millionaires' salad (destroys trees); the sap from bruised inflorescence fresh or fermented as toddy or vinegar, or evaporated to sugar; the young, immature fruits for their water and their jelly-like flesh, or grated and extracted with water to give coconut milk; the mature nuts for their water and flesh, dried as copra, extracted for oil and protein; the germinating seed for its root ball.

Feed: Fresh coconuts are eaten by many animals. The cake, after pressing out oil, is used for livestock feed.

Other products: The hull of the nut is made into tools, household items, or charcoal; the fibers of the husk used as fill, or woven; the trunk as post or milled to wood used in cabinets; the fronds woven into mats used for floors and walls. Many minor uses of other parts of the palm.

Suitability for special purposes:

Barrier plant: A neglected palm jungle is a formidable barrier.

Windbreak: Very useful in reducing the effects of the wind.

Shade: Shade for humans and animals and for crops grown below.

Alley cropping: Can be used in this fashion.

Animal shelter: A shelter for desired and undesired animals.

Lumber: An inferior but appreciated lumber source.

Fuel: Various parts of the palm are important sources of fuel.

Culture: The nuts, with husk, are half buried, on their sides, in moist soil where they will germinate. They can then be transplanted to permanent sites. The growing trees need fertilizer and protection from weeds and animals until well established. Very healthy trees can begin to bear in five years, and can live to be 100 years old. Coconuts have specific pests and diseases, the control of which is important.

Toxic characteristics: Numerous uses in folk medicine.

Other: There are many varieties of the coconut, some more suitable than others for specific purposes.

Coral Beans

Names: *Erythrina spp.*, numerous and varied, coral bean.

Principal use: Nurse and support for other crops.

Brief description: Small to very large leguminous trees with bright orange to red irregular flowers and pods with red seeds.

Climatic adaptation: Widely adapted; there are species for almost all tropical climates.

Yields: Food: A very few of these species are used for young edible pods or seeds. Others are used for the young leaves cooked as vegetables.

Feed: The leaves of some species are used as a feed for rabbits or serve as forage.

Other products: Tannin is extracted from the bark of some. Other ingredients were used in the production of curare.

Suitability for special purposes:

Living fence: Some species make excellent living fences.

Hedge: Some species make very good short to high hedges.

Living trellis: Some species are used as living trellis for viny crops.

Windbreak: The larger species can be used as windbreaks.

Shade: All are good sources of shade.

Erosion control: Excellent, fast-growing tree.

Earthworks: Suitable in some applications.

Alley cropping: Some species are very suitable for alley cropping.

Nitrogen fixation: Yes, all fix nitrogen and make it available to the soil.

Lumber: The wood is generally soft and can be used for carving.

Fuel: Quality of wood for fuel varies.

Culture: Planted from seeds, or in some cases from large woody stakes.

Toxic characteristics: In general, the seeds are poison and the foliage often contains alkaloids. These trees must be treated with caution.

Other: The red seeds are made into necklaces.

Plants for Use in Permaculture in the Tropics

Coral Beans, cont....

Some useful species:

- E. berteriana*: living fence, living trellis, forage.
 - E. edulis*: edible seeds.
 - E. indica*: white wood ground as face powder, fodder.
 - E. lithosperma*: nurse tree for coffee.
 - E. poeppigiana*: large nurse tree, soil enrichment, forage, windbreak.
 - E. variegata*: forage, ornament.
- (There are many other useful species.)

Corn, Maize

Names: *Zea mays*, corn, maize.

Principal use: A storable grain used for many purposes.

Brief description: Annual herb, upright, 2-4 meters, with long narrow leaves, a terminal male flowering cluster, and lateral female flowers with long stigmas.

Climatic adaptation: While corn is broadly adapted in the temperate zones and tropics, specific varieties and planting seasons are always required.

Yields: **Food:** The seed is an extremely important world food and feed, moderate in protein, oil and starch; immature ears boiled or roasted as a tender vegetable; the dried grain milled as flour, specially treated to form grits or make tortillas, etc.; extracted for oil or starch; the stalk of some varieties extracted for juice, boiled to syrup or sugar.

Feed: Most animals will eat the green foliage. The dried seed is a principal animal feed. The dry residues after harvest are eaten by cattle.

Other products: The dried residue can be used as poor quality thatch or as mulch. The seed and its extracts have numerous industrial uses. The dried cobs serve as fuel and their ash for insecticidal soap.

Suitability for special purposes:

Hedge: A rapidly growing summer hedge.

Living trellis: Corn is often used as a living trellis for beans and other crops.

Erosion control: Can be used for rapid cover on freshly moved soil.

Alley cropping: Used in systems of multiple cropping.

Fuel: Crop residues make rapidly burning fuel.

Culture: Planted from seed at the beginning of the rainy season, or during the season, timed to mature during the dry season. Needs lots of fertilizer, good weed control. Has many insect and some fungal problems, very specific and depend on location.

Toxic characteristics: Seed that is not dried properly may be attacked by fungi and become toxic.

Other: Corn is the third most important food crop worldwide and probably the most versatile in climatic adaptation and in uses.

Cowpea

Names: *Vigna unguiculata* (*V. sesquipedalis*, *V. sinensis*), and subspecies, forms known as cowpea (black-eye pea), catjang and yardlong (asparagus) beans.

Principal use: As a shelled mature but not dry seed.

Brief description: Annual climbing or bush legume with trifoliate leaves, bean-like flowers and long pods.

Climatic adaptation: Adapted to hot seasons of the tropics and the temperate zone. The subspecies and their varieties differ in appearance, uses, and in adaptability as well as insect and disease problems.

Yields: **Food:** Young pods, mature green seeds and dry seeds all are eaten. The leaves are also used as spinach-like greens.

Feed: Animals love the foliage and pods. The dried crop residues are eaten by cattle.

Suitability for special purposes:

Shade: Some varieties give temporary shade when grown on trellises.

Erosion control: A fast-growing plant useful for covering the soil.

Alley cropping: Climbing varieties useful when grown on trellises.

Nitrogen fixation: Yes, good plants for enriching the soil.

Culture: Planted from seeds. Some varieties require trellises for good yields.

Special problems: Insect pests and disease limit production in some areas.

Principal types:

Cowpeas: Short-lived bush, rapid and abundant production, used principally as shelled or dry seeds.

Catjang: Rapid, small seeded, climbing type, very productive, used for shelled peas, or young pods as snap beans.

Yardlong: Long pods produced in abundance, used as snap beans.

Plants for Use in Permaculture in the Tropics

Date Palm

Names: *Phoenix dactylifera*, date palm.

Principal use: The very sugary fruit for a wide variety of purposes.

Brief description: Stout, tall palm with very large crown of pinnate fronds, frequent offshoots at the soil level, large clusters of flowers and later fruits.

Climatic adaptation: The hot, dry temperate regions or subtropics, adapted to sandy soils, cool nights, and resists some frost.

Yields: Food: Use depends on variety. Soft fruits are eaten fresh, out of hand. Semidry are sun-dried and are choice fruit for export. Dry varieties are sun-dried and used as a staple food. Cooked or made into preserves, fermented into alcoholic beverages.

Feed: Leaves and fruits are used as animal feed.

Other products: Fibers of leaves, leaf base, and trunk are woven into a wide variety of products.

Suitability for special purposes:

Windbreak: Rows of trees as well as whole plantings serve as windbreak and effectively modify local microclimate.

Shade: Excellent shade where it is needed.

Erosion control: A source of useful mulch.

Lumber: The trunk of the palm is used for construction and the leaves are used for thatching.

Fuel: Makes a fair fuel where fuel is scarce.

Culture: May be planted from seeds, but selected varieties are recommended. These are obtained as offshoots of known trees.

Pollination is accomplished by tying a portion of the male inflorescence, in season, to the female inflorescence. Fruits are harvested at maturity which corresponds to their expected use.

Special problems: Date palms have numerous insect and disease problems, practically unknown in the western hemisphere.

Other: Success in growing dates begins with the right climate and continues with the right varieties.

Elephant Grass

Names: *Pennisetum purpureum*, elephant grass, Napier, Merker grass.

Principal use: As a high-quality perennial grass for cut feed.

Brief description: A tall, thick-stemmed, perennial grass forming a dense system of rhizomes, from which numerous new culms arise. The inflorescence is a dense spike produced on a long stem, 10 or more cm long and 1 cm in diameter.

Climatic adaptation: Adapted to the hot, humid tropics, tolerant of heavy soils and root flooding, and will live through a long drought.

Yields: Feed: A principal grass for feeding cattle, it is best cut and not grazed.

Other products: Useful as an abundant, easily-produced thatching material, and, when cut and dried, as a mulch. A potential source of pulp for paper.

Suitability for special purposes:

Erosion control: Very useful to control erosion because of its fast growth.

Culture: Elephant grass is usually established by planting three-noded cuttings in loosened soil, but, on a loose soil during the rainy season, the grass can be spread as a mulch which then roots. Fertilization might be desirable in a poor soil to speed establishment.

Toxic characteristics: The foliage may contain certain glycosides of hydrocyanic acid and occasional livestock poisoning has been reported. Frequently used in folk medicine.

Florida Velvet Bean

Names: *Mucuna deeringiana*, *Stizolobium deeringianum*, velvet bean, Florida velvet bean.

Principal use: Annual, automatically reseeding, summer and fall ground cover.

Brief description: Trifoliate, large-leafed, vigorous trailing and climbing vine which bears clusters of flowers during short days, followed by thick pods with large, grayish seeds. The foliage tends to cover all weeds and may even smother small trees. The vines die as the seeds mature.

Climatic adaptation: Widely adapted in the tropics, sea level to 2,000 meters, growing from early spring to late fall. The seeds need adequate moisture to germinate, but then the plants are drought tolerant as well as tolerant of heavy soils and tropical rains. Not tolerant of cool temperatures. Most varieties bloom during short days, but one matures in long days (but it has a pod with irritating hairs).

Yields: Food: Questionable use as a food although very young seeds are sometimes cooked as a shelled pea. The mature, dried seeds toasted and ground as a coffee extender or coffee substitute.

Feed: Makes an excellent, high-yielding, high-protein feed much appreciated by most animals.

Other products: Produces large amounts of green manure and dried mulch. Enriches the soil by nitrogen fixation and retrieval of deep nutrients.

Plants for Use in Permaculture in the Tropics

Florida Velvet Bean, cont....

Suitability for special purposes:

Erosion control: Excellent temporary ground cover.

Nitrogen fixation: Excellent.

Culture: The appropriate variety must be selected. The short day type does not have irritating hairs on the pods and is most useful in the tropics. During the spring, plant the seeds 25-30 cm apart, 2.5 cm deep, and provide moisture for germination. Growth is slow at first, then rapid. Keep pruned from valuable trees. Self-eliminating after seeding in winter. Will establish spontaneously the next spring, especially if plowed. If regrowth is not desired, seeds must be collected.

Special problems: The trichomes or hairs of the pods of some velvet beans loosen when the pods ripen and may be blown by the wind. They cause extreme itching.

Toxic characteristics: The seeds contain several antinutrients, including a volatile oil that irritates the eyes.

Guava

Names: *Psidium guajava*, guava.

Principal use: As a high vitamin C dessert fruit.

Brief description: Small to medium sized tree with ovate leaves, attractive many-stamened white flowers, and greenish to yellow spherical or pear-shaped fruits.

Climatic adaptation: Widely adapted in the tropics. Will tolerate heavy and sandy soils, low to heavy rainfall, from coastal to highland conditions.

Yields: Food: The fruit, mature or slightly green, as a dessert fruit, or cooked into preserves, or solidified into guava paste, or made into a nectar.

Feed: A common tree in pastures. The young leaves and the fruits are important forages for wild animals and for cattle.

Other products: The wood is prized for fuel.

Suitability for special purposes:

Hedge: One production technique is to grow guava as a hedge.

Barrier plant: Can form a dense barrier if pruned low.

Shade: An old, large tree provides good shade in the pasture or the yard.

Erosion control: While slow to grow, provides very good control of the soil.

Earthworks: A good tree to be used in earthworks because of its strength and lasting qualities.

Animal shelter: Naturally attracts and shelters birds.

Lumber: The hard wood has many uses where strength is needed.

Fuel: A hard and excellent firewood, also makes excellent charcoal.

Culture: Guavas are planted from seed. Selected varieties can be readily propagated as air layers. Since fruits are borne on new branches, benefits from frequent pruning.

Special problems: In some climates and in the case of some varieties, the fruits are attacked by a fungus which causes them to harden. Fruit flies are a pest of the mature fruits of some varieties, but some are fairly resistant.

Other: An important bee forage plant.

Guinea Grass

Names: *Panicum maximum*, Guinea grass.

Principal use: Easy to grow animal feed.

Brief description: Rapidly growing perennial pasture grass, growing in clumps up to 1.5 m tall with longer panicles. Panicles open with widespread florets, mostly sterile, producing few viable seeds. Rapidly growing from the beginning of the rainy season, later producing many tough stems.

Climatic adaptation: Widespread and well adapted in most parts of the tropics, especially the hot, humid tropics.

Yields: Feed: A principal forage grass, especially in unimproved pastures. Can be cut for hay.

Other products: Produces large amounts of potential mulch.

Suitability for special purposes:

Hedge: Suitable for rapid temporary fence.

Erosion control: Rapidly covering loose earth to provide protection.

Culture: Seeds, if available, can be scattered over loose soil. Clumps can be separated for hand-planting at 1 m intervals. Often old plantings are renovated by burning, a destructive practice.

Toxic characteristics: Ingestion of too much new foliage causes a disease, swelling of the head of sheep, due to a diamine.

Plants for Use in Permaculture in the Tropics

Gumbolimbo

Perhaps the best living fence for the hot, dry tropics.

Names: *Bursera simaruba*, Gumbolimbo, turpentine tree.

Principal use: Living fence for the hot, dry tropics.

Brief description: Medium-sized, partially deciduous tree with smooth trunk and peeling, rusty-brown bark, minute, green flowers, and clusters of small fruits.

Climatic adaptation: The hot, dry tropics and subtropics.

Yields: Food: Leaves are used as tea.

Feed: Not eaten by animals.

Other products: Resin used in varnishes, or as a household glue, or burned as incense.

Suitability for special purposes:

Living fence: Excellent, planted as post-sized cuttings.

Hedge: Can be grown as a large hedge.

Living trellis: Suitable as a living trellis in dry areas.

Shade: A welcome shade in dry areas.

Erosion control: Useful tree in erosion control systems in dry regions.

Lumber: Wood makes poor lumber.

Fuel: The soft wood makes useful, but poor quality, fuel.

Culture: Planted from large cuttings or from seeds. New cuttings and young seedlings will benefit from some irrigation.

Toxic characteristics: All parts of the tree are resinous, might be slightly toxic.

Other: A wide variety of medical uses.

PHOTO ON P. 25.

Holosericea

Names: *Acacia holosericea*.

Principal use: The seed is a nutritious pulse for the hot, dry tropics.

Brief description: Fast-growing, small leguminous tree with pinnately compound leaves, clusters of flowers appearing after spring rains, and pods of edible seeds.

Climatic adaptation: Adapted to the hot, dry tropics.

Yields: Food: The dry seeds are ground as a meal which is used in many dishes. The meal has a high protein and medium oil content.

Feed: The pods and young leaves make good fodder.

Suitability for special purposes:

Living fence: Yes, can be planted from large stakes.

Hedge: Can be grown as a hedge.

Erosion control: Useful for erosion control on desert lands.

Alley cropping: Can be used for alley cropping.

Nitrogen fixation: Yes.

Lumber: The wood is used for pulp, and is a minor source of lumber.

Fuel: Used as firewood and for charcoal.

Culture: Planted from seeds. Can also be planted from cuttings.

Toxic characteristics: The potential toxic characteristics of the seeds when used as a staple have not been assessed.

Other: Begins producing seed as early as the second year. The tree is also valuable as an ornamental. This particular species needs more extensive study as a potentially valuable species. From Australia.

Honeylocust

Names: *Gleditsia triacanthos*, honeylocust.

Principal use: Green and mature pods, fresh and fallen leaves as feed.

Brief description: Small to medium-sized thorny or thornless tree, with pinnately compound leaves, produces large quantity of pods, each 30-40 cm long. Sprouts from the roots.

Climatic adaptation: Adapted to the temperate zone and seldom seen in the tropics. Drought resistant when established. Possibly of value in upland tropics.

Yields: Food: The pods are sucked for their sweet pulp, and sugar can be extracted from them.

Feed: Animals eagerly eat leaves and pods.

Other products: Fuel.

Plants for Use in Permaculture in the Tropics

Honeylocust, cont....

Suitability for special purposes:

- Living fence: Easily grown as a living fence.
- Hedge: Makes a thick, almost impenetrable hedge.
- Living trellis: Light foliage permits other crops to grow up into its branches.
- Windbreak: A rather short windbreak.
- Shade: The shade is light and other crops can be grown below.
- Erosion control: Very useful.
- Earthworks: A useful tree.
- Nitrogen fixation: Yes, and deep nutrient recovery as well.
- Lumber: Inferior lumber can be taken from the tree.
- Fuel: Good quantity and fair quality firewood.

Culture: Planted either from seeds or from root suckers.

Special problems: The thorns are very troublesome. Shoots from thornless trees can be used to avoid this problem.

Toxic characteristics: Many medicinal uses. A leaf preparation increases ability to do heavy work. Contains an alkaloid, triacanthine.

Horseradish Trees

Names: *Moringa oleifera*, and *M. stenopetala*, horseradish tree, drumstick tree, malungay.

Principal use: Year-round production of a highly nutritious green-leafed vegetable.

Brief description: Small to medium-sized trees (can be maintained as a hedge) with tripinnate leaves, clusters of white flowers, long, three-sided pods, and marble-sized, round seeds.

Climatic adaptation: Best adapted to the hot tropics (frost sensitive), in areas of low rainfall. Tolerant of the hot, humid tropics, of drought, and of beach (saline) conditions, but not of root flooding.

Yields: Food: Leaves, flowers, and young pods, cooked. Root as a condiment. Seeds roasted.

Feed: Animals must learn the new taste.

Other products: Seeds are crushed in water to remove turbidity. Seeds contain a useful lubricating oil, sometimes used in cooking (high in oleic acid). Seeds contain a sharp-tasting alkaloid, nuclein.

Suitability for special purposes:

- Living fence: Excellent, from large stakes.
- Hedge: Excellent, if heavily pruned.
- Barrier plant: Very good.
- Living trellis: Poor.
- Windbreak: Fair (too small).
- Shade: Fair, not dense.
- Erosion Control: Poor
- Earthworks: Poor.
- Alley cropping: Good, if heavily pruned.
- Animal shelter: Poor.
- Nitrogen fixation: Probably not.
- Lumber: No, the wood is very soft.
- Fuel: Excellent amounts, poor quality.

Culture: Plant in container or on site from large seeds, or 3-4 foot cuttings. Water requirements normal at first, low later. Nutrient conditions need not be special. Growth is rapid. Prune frequently to size and shape. For leaf production, increase soil fertility and water.

Special problems: None described.

Toxic characteristics: None described.

Other: Many medicinal uses throughout the tropics.

Indian Almond

Names: *Terminalia catappa*, tropical almond.

Principal use: Easy to grow nut.

Brief description: Medium sized, fast-growing tree, trunk up to .6 m diameter, almost horizontal branches in whorls, leaves broad, obovate in shape, shiny, becoming yellow to red with age, short clusters of small white flowers attracting bees, flattish fruits up to 7.5 cm.

Plants for Use in Permaculture in the Tropics

Indian Almond, cont....

Climatic adaptation: Adapted to seaside conditions of the tropics, sandy soil, salinity, frequent rains, and occasional root flooding. Also grown inland under variable conditions.

Yields: Food: The pulp of the ripe fruit is edible and can be used in preserves or wine. The kernel is a nutritious nut, small, cylindrical, eaten fresh or roasted. It contains 50-60 percent oil and a good quantity of protein.

Feed: The leaves are feed for a silkworm. The fruits are eaten by pigs.

Other products: Leaves, bark, and fruits are used for tanning hides. The wood is useful as lumber.

Suitability for special purposes:

Hedge: Can be grown and pruned as a living fence.

Windbreak: Can be grown as a windbreak.

Shade: Excellent shade tree.

Erosion control: Can be used to stabilize banks of soil.

Lumber: A fair lumber can be had from the tree.

Fuel: A good quantity and fair quality of fuel is produced.

Culture: The tree is easily grown from the large, dried fruit, and can be transplanted. No special care is required, and flowering and fruiting occur as early as the third year.

Toxic characteristics: None reported. Many uses in folk medicine.

Other: Produces an insoluble gum.

Jack Bean

Names: *Canavalia ensiformis*, jack bean, horse bean (closely related species, the sword bean, *C. gladiata*.)

Principal use: Cover and green manure crop.

Brief description: Vigorous annual leguminous bush with large, trifoliate leaves, clusters of attractive flowers, and long (40 cm) pods.

Climatic adaptation: Hot tropics, from low to high rainfall, acidic to slightly alkaline soils, low to mid elevation, and summer growth.

Yields: Food: The immature pods, 1/3 to 1/2 full size, are cooked as snap beans.

Feed: The foliage is very much appreciated by cattle.

Other products: Large amounts of mulch or green manure.

Suitability for special purposes:

Shade: Temporary shade when grown on a trellis.

Erosion control: Excellent, rapidly growing cover.

Nitrogen fixation: Very good.

Culture: The large seeds are planted in loose, damp soil 3-5 cm deep, and about .5-1 m apart, at the beginning of the rainy season or season of long days. Plants flower and produce seed in 3-6 months.

Toxic characteristics: All parts of the plant contain poisonous substances. Livestock poisoning has been reported. Young pods should be well cooked and not eaten in excess. Eating of mature seeds should be avoided.

Jackfruit

Names: *Artocarpus heterophyllus*, jackfruit. (Similar comments could be made for *A. integer*, chempedak.)

Principal use: The immature fruit is cooked as a vegetable.

Brief description: Tall, upright tropical tree with ovate dark green leaves, a compact spike which develops into a very large fruit.

Climatic adaptation: A tree of the hot, humid tropics.

Yields: Food: The unripe fruit, cooked as a vegetable, the pulp around the seeds of the ripe fruit, as a dessert, the chestnut-like seeds boiled. The very young leaves are cooked as a vegetable.

Feed: The fruit and seeds are excellent pig feed.

Jackfruit, cont....

Other products: A good source of useful timber on the small farm.

Suitability for special purposes:

Windbreak: The large trees are suitable for windbreaks.

Shade: The shade is dense, but beware of the fall of a giant fruit.

Lumber: A useful tree.

Fuel: The wood makes a useful fuel.

Culture: Planted from seeds. Rapidly growing under good conditions.

Plants for Use in Permaculture in the Tropics

Jerusalem Thorn

Name: *Parkinsonia aculeata*, Jerusalem thorn, hore-bean.

Principal use: A multiple-purpose tree of the desert.

Brief description: Small to medium sized leguminous tree, very spiny, long cylindrical pods with many seeds.

Climatic adaptation: Adapted to desert conditions, degraded land, alkaline soils, tolerates high temperatures, salinity, even light frost. Will not tolerate waterlogging.

Yields: Food: Fruit pulp is sweet, edible. Seeds of some species are ground as meal. Very young leaves are cooked as spinach.

Feed: Pods and leaves as fodder for goats, sheep, rabbits.

Suitability for special purposes:

Living fence: Yes, can be rooted from large cuttings.

Hedge: Makes a good desert hedge.

Living trellis: Quite useful as a living trellis because of its light shade.

Windbreak: While not tall, makes a useful windbreak.

Erosion control: Useful for erosion control in desert situations.

Alley cropping: Needs trial for alley cropping in the desert.

Nitrogen fixation: Yes.

Lumber: Hard wood used for small objects.

Fuel: Very good as firewood or for charcoal.

Culture: Seeds must be scarified. Planted as seeds, transplanted seedlings, or as cuttings. Regrows nicely after being cut back.

Special problems; May be invasive in some places.

Other: Suitable as an ornamental. Used for medicinal purposes.

Katuk

Names: *Sauropus androgynus*, katuk, Southeast Asian asparagus.

Principal use: A tropical, spinach-like vegetable of high nutritional value.

Brief description: Upright, slightly woody perennial shrub with simple leaves on horizontal branches that look like compound leaves, these bearing many male and a few female flowers, producing a white pod with several seeds. A frequently harvested plant will have many upright branches.

Climatic adaptation: The hot, humid tropics. Tolerant of heavy rains and flooding.

Yields: Food: The young tips snapped off and boiled, or stir-fried as a delicious vegetable; the leaves boiled as spinach.

Suitability for special purposes:

Hedge: During the rainy season, long cuttings can be planted as a hedge or a small fence.

Alley cropping: Should be tried in alley cropping systems.

Nitrogen fixation: Should be tested, due to the vigor of the species.

Culture: Planted from seeds or from cuttings, needs rich culture to produce abundant tender greens.

Toxic characteristics: Said to cause low blood sugar, possibly associated with an eye problem, when eaten in large amounts.

Other: A gourmet vegetable of the tropics.

Kudzu

Names: *Pueraria phaseoloides*, kudzu, tropical kudzu.

Principal use: As a vigorous ground cover.

Brief description: Rapidly growing trailing or climbing vine with large trifoliate pubescent leaves, purple flowers, and small, flattened pods.

Climatic adaptation: The tropics in general, especially the hot, humid tropics. Tolerant of flooding and heavy soils.

Yields: Food: The fleshy root is edible as a vegetable, but many plants do not produce a fleshy root. The young leaves and very young pods are sometimes cooked as vegetables.

Kudzu, cont....

Feed: A feed crop esteemed by cattle and eaten by most domestic animals.

Other products: Starch can be extracted from the partially tuberized roots.

Suitability for special purposes:

Shade: A useful temporary shade when grown over a trellis.

Erosion control: A very useful plant to rapidly cover loose soil, for it roots at the nodes and provides a dense cover.

Plants for Use in Permaculture in the Tropics

Kudzu, cont....

Nitrogen fixation: Yes.

Culture: Planted from seeds. Can also be planted from rooted sections of the vine. Needs frequent pruning.

Special problems: May become weedy in some climates, capable of climbing small trees and smothering them.

Lablab Bean

Names: *Dolichos lablab*, *Lablab purpureus*, lablab bean, hyacinth bean.

Principal use: As a dried pulse for food.

Brief description: Annual or weekly perennial trailing or climbing vine with attractive flowers and short, wide pods.

Climatic adaptation: Adapted to the hot tropics in regions from low to high rainfall, low and high elevations. Most varieties grow as a vine during long days and as a bush during short days. When well developed, resists severe drought.

Yields: Food: Young pods of some varieties as a snap bean, mature green seeds as shelled peas, dry seeds as a pulse. Protein concentrate from milled, extracted seeds. Flowers may be cooked as a vegetable. Bean sprouts.

Feed: An excellent forage, particularly good during dry seasons, temporary legume in pastures.

Other products: Source of green manure.

Suitability for special purposes:

Erosion control: An excellent plant for reduction of erosion on loose soil.

Nitrogen fixation: Fixes nitrogen and retrieves deeply buried minerals.

Culture: Planted at the beginning of spring rains or long days to cover the soil and to smother weeds, at the beginning of short days for the bush form. A trellis is desirable for high yields.

Toxic characteristics: Cattle sometimes need time to adjust to eating lablab bean. Mature seeds contain trypsin inhibitor and cyanogenic glycoside, and therefore need thorough cooking.

Other: Varieties are available for special purposes.

Leucaena

Names: *Leucaena leucocephala*, leucaena, ipil-ipil.

Principal use: Tropical forage.

Brief description: Small to medium-sized, rapidly growing, leguminous tree with pinnately compound leaves, flowers clustered in a white to gray pin-cushion type arrangement, and clusters of flat pods containing flat, brownish seeds.

Climatic adaptation: Adapted principally to the hot, somewhat dry, tropics, growing best in almost neutral to somewhat alkaline soils. Once established, it can tolerate very dry conditions. Yet leucaena can also be established, but with some difficulty, in heavy, poorly drained clay in the hot, humid tropics.

Yields: Food: The tender branch tips and the very young pods are frequently cooked as vegetables. The seeds are sometimes roasted as a coffee extender or substitute.

Feed: A favorite feed of cattle, leucaena is best used at a ratio of 1:2, leucaena:grass. Causes loss of hair in some animals. A very valuable feed if used cautiously.

Other products: Green foliage for use as mulch or green manure, or dried and used as a fertilizer. Produces large amounts of firewood of fair quality.

Suitability for special purposes:

Living fence: Suitable, but cannot be established from cuttings.

Hedge: Excellent. Needs heavy pruning.

Barrier plant: Very good.

Living trellis: Suitable for some vigorously climbing crops.

Windbreak: Not tall enough.

Shade: No.

Erosion control: Useful to hold soil with deep roots, cover surfaces.

Earthworks: Fair, wood not durable.

Alley cropping: The material of choice for this activity.

Animal shelter: Fair.

Nitrogen fixation: Yes.

Lumber: Fair, but the wood of poor quality.

Fuel: Excellent.

Culture: Soak seed in water of 80° C. for 3-4 minutes, then cool in running water and air dry. The seeds can then be planted immediately or later. In some soils, must be inoculated with *Rhizobium*. Strips for planting should be cleared and plowed. In

Plants for Use in Permaculture in the Tropics

Leucaena, cont....

trees need protection from weeds. They are established faster with some fertilizer. Growth is slow at first, then rapid. Frequent pruning is necessary, and prunings are used for mulch, fuel and feed.

Special problems. Often not successful in very acidic soil.

Toxic characteristics: The foliage contains a poisonous amino acid, mimosine, that causes loss of hair.

Other: Appropriate varieties are very important. The giant type is best for alley cropping; Peru or Cunningham in pastures. The small West Indian form tends to be very weedy.

Mahoe, Hau

Names: *Hibiscus tiliaceus*, mahoe, hau, fau.

Principal use: Source of fibers for multiple applications.

Brief description: Small to medium-sized tree with irregular branching, often multiple trunks, and branches rooting where they touch the soil. Leaves heart-shaped to almost circular, with definite nipple at the tip. Flowers are large like those of hibiscus, yellow, turning orange in the afternoon, and red upon falling the next day.

Climatic adaptation: The hot, humid tropics. Tolerant of saline and swampy conditions near the sea. Successful up to 1,000 m above sea level.

Yields: Food: The small, tender leaves as well as the buds and the open flowers are cooked as vegetables. They are available year-round.

Other products: The tree is best known for its fiber, which is taken directly from the cortex (white, inner bark). It can be used directly as strings, or can be woven, with or without soaking or retting, as ropes, fishing nets, bags, cloth, including sails. The cortex is also scraped to provide a finer fiber, and this can be used as cloth or pounded into fine, cloth-like sheets (tapa).

Suitability for special purposes:

Living fence: Large stakes easily root.

Hedge: Fair, but makes a very thick hedge.

Barrier plant: Excellent.

Living trellis: Poor, foliage too dense.

Windbreak: Poor, too short and thick.

Shade: Can be trimmed as a fine shade tree.

Erosion control: Can be used as a crude barrier in erosion control.

Earthworks: A good tree to cover the soil and hold with roots.

Alley cropping: Poor.

Animal shelter: Yes.

Nitrogen fixation: Probably not.

Lumber: The wood is flexible, light, but durable.

Fuel: Good quantity but fair quality.

Culture: The tree can easily be established in normal soil with the large seeds. Woody cuttings to several inches in diameter are easily rooted. The tree is frequently grown casually on the farm, without special attention.

Special problems: Growth is often excessive and usually requires frequent pruning. The falling flowers can be objectionable near the house.

Toxic characteristics: None known. Eating flowers and leaves might be laxative.

Malabar Chestnut

Names: *Pachira aquatica*, Malabar chestnut, guinea chestnut, provision tree.

Principal use: The large seed, boiled, fried, or roasted as food.

Brief description: Small to large (5-25 m) tree with large, alternate, palmately divided leaves, large, spectacular flowers, and woody capsules up to 12 cm long by 8 cm wide, filled with 20-30 irregularly shaped seeds.

Climatic adaptation: Adapted to the hot, humid tropics, in wet places, along stream banks, or elsewhere when planted and cared for. Tolerates heavy rains and occasional flooding, but not drought.

Yields: Food: The large seeds, high in fat and with good protein and carbohydrate contents, high in niacin, with some vitamin C. The young leaves and flowers are also used as vegetables.

Other products: Gum from trunk is used as a water-resistant caulk, a red dye is produced from the bark. The wood is useful as pulp for paper, and the oil from the nuts can be used in making soap.

Suitability for special purposes:

Barrier plant: Because of rapid growth, can be used as a quick fence or barrier plant.

Shade: A good shade tree.

Lumber or fuel: The wood is soft and not good for either purpose.

Plants for Use in Permaculture in the Tropics

Malabar Chestnut, cont....

Culture: Seeds germinate 6-8 days after planting and initial growth is rapid. Under fertile conditions, growth continues rapidly, and trees can begin to bear while quite small. Harvest mature but unopened capsules for the best flavor, or gather the seeds under the trees.

Toxic characteristics: None recorded.

Mango

Names: *Mangifera indica*, mango.

Principal use: As a mature fruit eaten out of hand.

Brief description: Large to very large tree with long, narrow leaves, small greenish-yellow flowers in clusters and green to orange and red fruits with interior yellow to orange.

Climatic adaptation: The hot tropics with a monsoon climate. During flowering, low rainfall and low humidity are important for fruit set. Will tolerate occasional flooding.

Yields: Food: Sometimes considered the best fruit of the tropics. Used mature green or ripe as a fresh fruit; combined in salads and drinks; pickled, made into chutney; dried and powdered; cooked and canned; made into preserves, jelly, jam. Young leaves sometimes eaten. The cotyledons of the seed can serve as an emergency food.

Feed: Fruits that have fallen to the ground are eaten by animals. The interior of the seeds is sometimes used as feed.

Suitability for special purposes:

Barrier plant: Can be used as a large barrier.

Windbreak: Each tree is an excellent windbreak.

Shade: Excellent, except when fruits are dropping. Small animals can be reared in the dense shade.

Animal shelter: Animals find shelter in and under the tree.

Lumber: The wood is used for cheap furniture.

Fuel: A fuel of moderate quality.

Culture: Planted from seeds, with or without removal of seed coat. Seedlings are grafted with scions of superior varieties. Better varieties are fertilized and cared for.

Special problems: Most trees are too large for the small farm. They dominate large areas and their roots may interfere with foundations. They are easily blown over with severe winds, and thus can damage structures. Some varieties are grafted on dwarfing root stocks.

Toxic characteristics: Some people are allergic to the fruit, and even more so to the sap of the fruit and the tree.

Other: There are many uses in folk medicine.

Mother of Cocoa

Names: *Gliricidia sepium*, mother of cocoa, madre de cacao, black wood.

Principal use: Living fence.

Brief description: Small to medium sized leguminous tree with pinnately compound leaves lost during the dry season, clusters of pink flowers, and slim pods.

Climatic adaptation: Adapted to the monsoon climate of the hot, humid tropics, tolerant of seasonal dry weather, mostly at low elevations.

Yields: Food: The flower and flower buds are boiled or fried as a vegetable, as are the very young leaves.

Feed: The branches are cut as feed, especially during the dry season when other feeds are unavailable.

Other products: Quantities of mulch can be obtained.

Suitability for special purposes:

Living fence: Excellent, the tree of choice in many parts of the tropics.

Hedge: Very good, but needs frequent pruning.

Shade: Used as shade tree for coffee and cocoa.

Erosion control: Excellent tree because of its easy establishment and rapid growth.

Earthworks: A useful tree.

Alley cropping: Useful.

Nitrogen fixation: Yes, and retrieves deep minerals as well.

Lumber: The inner wood is hard and black, used to make small, durable articles.

Fuel: A good fuel, especially the heart wood.

Culture: Easily established where desired from large cuttings or stakes. Can be planted from seed as well.

Toxic characteristics: Seeds and bark are ground and mixed with grain to obtain an effective rat poison. Some caution in the use of the plant as food or feed is desirable.

Plants for Use in Permaculture in the Tropics

Neem

Names: *Azadirachta indica*, neem.

Principal use: Seeds and leaves for insecticidal purposes.

Brief description: A small to medium tree with pinnately compound leaves and dentate leaflets, bearing clusters of flowers and small fruits.

Climatic adaptation: Widely adapted in the tropics, tolerant of very poor soils and drought.

Yields: Feed: The foliage is eaten by cattle.

Other products: The leaves and seeds are used as insecticides in many ways. Oil is extracted from the seeds (margosa oil) for medicinal uses.

Suitability for special purposes:

Hedge: Can make a very good hedge.

Shade: In dry climates, this tree may be a very welcome shade.

Reforestation: An excellent tree for reforestation in dry regions, and somewhat useful for erosion control.

Alley cropping: May be useful in alley cropping for its insect repellent qualities.

Lumber: A useful tree for lumber.

Fuel: A very useful fuel wood.

Culture: Planted from seeds. The seeds tend to be difficult to germinate, but can be germinated by very careful removal of the seed coat.

Toxic characteristics: This insecticidal tree is of course toxic.

Other: Used for many medicinal purposes. A tea is made from the leaves.

Okra

Names: *Abelmoschus esculentus*, okra.

Principal use: The immature pods are cooked as a nutritious vegetable.

Brief description: Annual or weak perennial somewhat woody shrub, erect and branching with large, palmately-lobed leaves, large yellow flowers, and a 4 to many-sided or cylindrical pod, tapering toward the tip, spherical seed 3 mm in diameter.

Justification for inclusion as a permaculture crop: Okra is easy to grow, productive, and has a very wide range of uses.

Climatic adaptation: Okra is adapted to hot climates and long sunny days. However, an African form, now known to be a species hybrid, produces during short days.

Yields: Food: Young leaves as a boiled vegetable, tender pods at any stage, mature green pods for the extracted seeds, dried seeds are extracted for oil or protein or are extracted and precipitated as a vegetable cheese. Seeds are milled and sifted to produce flour.

Other products: The green stems are a source of fiber for cordage or basket making or to make excellent paper. The dried stems are used as fuel. The mucilage from the pods and foliage can be used for several purposes, including the sizing of paper.

Suitability for special purposes:

Hedge: Can make a rapidly growing temporary fence.

Erosion control: Useful for rapid control of loose soil.

Alley cropping: Can be used in alley cropping.

Fuel: Useful as fuel.

Culture: Soil is loosened and seeds are planted 1-2 cm deep when rain or irrigation is available, and days are lengthening. Young plants are thinned to 20cm in the row and 1 m between rows. Plants are fertilized if rapid growth and high yields are desired. Pods are harvested at the suitable stage according to use.

Special problems: Okra is very susceptible to nematodes and may do poorly for this reason in sandy soils. Rotation of fields is necessary.

Toxic characteristics: Formerly believed that the seeds contain a poison, gossypol. The current evidence is that the substance is not gossypol and is not poisonous.

Owala Oil Tree

Names: *Pentaclethra macrophylla*, owala oil tree.

Principal use: Source of an edible oil.

Brief description: Large leguminous tree with pinnately compound leaves and pods with large, oily seeds.

Climatic adaptation: Adapted to the hot, humid tropics.

Yields: Food: The seeds are ground and used in a variety of foods, including breads. The oil is extracted for use in foods.

Feed: The shoots and leaves are used as fodder.

Plants for Use in Permaculture in the Tropics

Owala Oil Tree, cont....

Other products: The oil is used for several purposes, including making candles. The wood is hard and is carved into useful, durable objects. The bark is a source of tannin and dyes.

Suitability for special purposes:

Windbreak: A suitable windbreak of medium height.

Shade: Provides useful shade for home and for animals.

Nitrogen fixation: Yes.

Lumber: The hard wood is used for lumber.

Fuel: The wood makes excellent charcoal and fuel.

Culture: Planted from seeds.

Toxic characteristics: Seeds of the related American species, *P. filamentosa*, contain a poisonous alkaloid. This suggests cautious use of the seeds as food.

Other: A lotion made from the bark is used to treat small wounds.

Palmyra Palm

Names: *Borassus flabellifer* and *B. aethiopum*, palmyra palm.

Principal use: Sugar and toddy from crushed inflorescence.

Brief description: Stout, tall palm with fan-shaped leaves and clusters of nuts.

Climatic adaptation: Adapted to the hot dry tropics, especially to sandy and well-drained soils, common in lowland areas.

Yields: **Food:** Sap flow is stimulated by cutting or crushing the inflorescence, evaporated to sugar, fermented to toddy or vinegar. Young fruits cooked as a vegetable; pulp or mature fruit edible. Oil is extracted from the kernel. The seed is sprouted and then eaten. The roots are also cooked as a vegetable. Starch may be extracted from the trunk.

Feed: The leaves and fruits are used as fodder.

Other products: The palm is a source of several kinds of fiber used for weaving, for rope, for sieves. The leaves are used for thatch and as writing material. The seed oil is used as an illuminant. A dye is also extracted.

Suitability for special purposes:

Windbreak: A row of palms makes a rather open but useful windbreak.

Shade: Useful as a household shade and ornamental tree.

Erosion control: The leaves are used for mulch.

Lumber: The wood is used as posts and for heavy timbers. Versatile wood.

Fuel: The spent leaves make good fuel.

Culture: Planted from seeds. Seedlings may be transplanted.

Toxic characteristics: An extract of the root is used as a slow poison.

Other: Several medicinal uses are well documented.

Pangola Grass

Names: *Digitaria decumbens*, pangola, pangola grass.

Principal use: An excellent forage grass.

Brief description: Vigorous perennial grass in tufts, spreading by stolons, rooting at the nodes. Forms a mat about 8-12 inches thick and smothers weeds.

Climatic adaptation: Widely adapted in the tropics, tolerant of dry conditions when well established, and of heavy soils and occasional flooding.

Yields: **Feed:** A high-yielding pasture crop.

Other products: Can be used as a lawn grass. Responds well to mowing.

Suitability for special purposes:

Erosion control: Is an excellent ground cover for protection against erosion.

Culture: Does not normally seed. Planted from stolons. Must be watered after planting until rooted. Benefits from occasional fertilizer. Like all grasses, should not be overgrazed.

Special problems: Sometimes attacked by aphids and more rarely by virus.

Papaya

Names: *Carica papaya*, papaya, pawpaw.

Principal use: Uncooked, as a dessert fruit, high in vitamins A and C.

Plants for Use in Permaculture in the Tropics

Papaya, cont....

Brief description: Single-stemmed, upright or sparsely-branched succulent, short-lived tree with large, spreading, palmately divided leaves, male, female and hermaphroditic plants, the males in long clusters, the others in solitary or small clusters, near the trunk, forming large fruits along the trunk that yellow as they ripen.

Climatic adaptation: Widely adapted in the tropics, especially to low and mid elevations, tolerant of heavy soils, some flooding, of light soils if well watered, and of some drought.

Yields: Food: The green fruit cooked as a vegetable or made into candies; the ripe fruit as a dessert, or prepared as juice. (Excellent frozen as well.) The young leaves are sometimes eaten as a vegetable. The seeds fresh or dried can be used as a peppery condiment.

Feed: Animals eat the fruits.

Other products: The latex is extracted and dried and used as a meat softener. The leaves are wrapped around meat for the same purpose.

Suitability for special purposes:

Alley cropping: Can be used with other crops in multiple cropping systems.

Culture: Plants are normally grown from seeds and can be established directly in the field if carefully cared for, or planted into pots. Growing papayas need adequate water and plenty of fertilizer. They suffer from weed competition. Trees can begin to bear in less than one year, and fruits are picked when they begin to turn yellow.

Special problems: In some areas, papayas suffer from virus diseases. The bunchy top disease requires constant insect control. The ring-spot virus is best resisted with tolerant varieties. Papayas are easily damaged by excess winds. They do not tolerate nematodes or excess flooding. Fruit flies hinder papaya production in some areas.

Toxic characteristics: Overeating papaya may give severe stomach pains.

Other: Varieties exist as male-female or female-hermaphrodite. The latter is preferred as all plants will produce fruit.

Paradise Tree

Names: *Simarouba glauca*, paradise tree, aceituno.

Principal use: Makes a bitter tea to treat fever.

Brief description: Small to medium-sized tree with long, pinnately compound leaves, dark, shiny leaflets, flowers in clusters, followed by fruits that mature purple.

Climatic adaptation: Adapted to the hot and humid or sub-humid tropics and subtropics. Found as a summer annual even in the temperate zone.

Yields: Food: Fruits can be used as a source of edible oil. The seeds are said to be edible. Leaves can be used to make bitter tea.

Suitability for special purposes:

Shade: An excellent shade and ornamental tree, used as a nursery tree for other crops.

Erosion control: Useful in reforestation and erosion control. Has a shallow, spreading root system.

Lumber: The wood is used in carvings and as posts.

Fuel: Used as a fuel.

Culture: Planted from its large seeds.

Toxic characteristics: The fruit pulp, after removal of oil, is toxic.

Parkia

Names: *Parkia* spp. 1. *P. africana* (*P. biglobosa*), African locust; 2. *P. filicoidea*, West African locust; 3. *P. javanica*, kedaung; 4. *P. speciosa*. There are also other species.

Principal use: The flesh of the pod or the seed, as food.

Brief description: Medium to tall leguminous trees.

Climatic adaptation: All are best adapted to the hot, humid tropics.

Yields: Food: 1: Edible fruit pulp, also used in drinks; seeds as condiment or coffee substitute, or fermented; edible leaves. 2: Pulp ground as meal; seeds as condiment, fermented. 3: Young seeds boiled as food. 4: Seeds popped in the shell as food; pods as condiment.

Feed: 1, 2, 4.

Other: 1: Bark medicinal, for tanning, dyes, soil conservation, mulch. 2: Bark for tanning, medicinal. 3: Medicinal.

Suitability for special purposes:

Living trellis: Tall trees make suitable trellises for vigorous vine crops.

Windbreak: Very suitable windbreaks.

Shade: Good shade for homes, pastures, or shade-tolerant crops.

Nitrogen fixation: Yes.

Plants for Use in Permaculture in the Tropics

Parkia, cont....

Lumber: All are good sources of lumber.

Fuel: All are sources of good fuel.

Culture: Planted from seeds or transplanted as seedlings.

Special problems: All of these trees are too large and too slow-growing for most small farms or permaculture systems.

Toxic characteristics: Caution. Seed of the related *P. bussei* are poisonous.

Other: The entire genus needs study and evaluation for the logical place on small farms and permaculture systems.

Peanut

Names: *Arachis hypogaea*, peanut, groundnut.

Principal use: As a high oil, high protein seed.

Brief description: Annual small bushy herb with yellow flowers, that after flowering bury their pods in the soil.

Climatic adaptation: Widely adapted in hot tropical and temperate regions, but requires specific, adapted varieties. Benefits from light soil.

Yields: Food: The unripe pods can be used as a vegetable. The ripe seeds are used as a pulse, or as a nut, raw or roasted, extracted for oil, or ground into peanut butter.

Feed: Animals love the green foliage. Seeds are valuable feeds. Cattle eat the dried crop residues.

Other products: The seeds have numerous industrial uses.

Suitability for special purposes:

Erosion control: A rapid, temporary cover for disturbed areas.

Multiple cropping: Other crops may benefit from the nitrogen fixed.

Nitrogen fixation: Yes, useful crop for soil enrichment.

Culture: Peanuts are planted from seeds to grow during the wet season and to mature during the dry season. Sandy soils are desirable. Fertilizer is desirable for maximum yields.

Toxic characteristics: Seeds matured under wet conditions can be infected by fungi and become toxic.

Other: Such a valuable crop for the small farm should be considered for potential use. Adjustment of the season of planting is necessary.

Pigeon Pea

Names: *Cajanus cajan*, pigeon pea.

Principal uses: The shelled or dried seeds as pulses.

Brief description: Woody, short-lived perennial shrub with trifoliate leaves, yellow flowers, and short pods of 3-7 seeds.

Climatic adaptation: Widely adapted in the tropics. After seeds germinate, plants can tolerate drought. Most varieties are adapted to short-day flowering but day neutral varieties have been developed.

Yields: Food: The pods are harvested when plump for shelled peas, or when dry. The young leaves are cooked as spinach.

Feed: The foliage and pods are relished as feed by farm animals.

Suitability for special purposes:

Hedge: Makes a good temporary fence.

Erosion control: Can be very useful in loose soil for erosion control.

Alley cropping: Now recognized as a principal species for alley cropping.

Nitrogen fixation: Yes, also grown as green manure.

Fuel: The plant residues are used as fuel.

Culture: Planted from seeds at the beginning of the summer rainy season. Needs little attention.

Special problems: Insect infestation of the pods is a common problem.

Pili Nut

Names: *Canarium ovatum*, pili nut.

Principal use: A nut high in oil for human consumption.

Brief description: Large, upright tropical tree with pinnately compound leaves, large dark green leaflets, small flowers born in clusters followed by plum-shaped fruits maturing purple.

Climatic adaptation: Hot, humid tropics, tolerant of heavy soils, also fairly tolerant of long, dry seasons.

Yields: Food: The fruit pulp made into preserves. The nut eaten raw (in small quantities), or roasted, or made into numerous products (nut butter, candy bars, adulterant in chocolate). The oil expressed or removed by solvents as an excellent food oil.

Plants for Use in Permaculture in the Tropics

Pili Nut, cont....

Other products: The wood is a very good timber.

Suitability for special purposes:

Windbreak: The trees make tall and effective windbreaks.

Shade: The shade is dense and useful for people and animals.

Lumber: Makes a very good lumber tree.

Fuel: Makes a good fuel wood and charcoal.

Culture: Planted from fresh seeds. Better varieties can be grafted. Can be planted in heavy soils and wet locations. For rapid growth, keep weed-free, give moderate fertilization, and water moderately. Nuts are picked from the ground. If the pulp is desired, fruit should be harvested directly from the tree.

Special problems: Trees need several years of growth before bearing and are then fairly large.

Toxic characteristics: Uncooked seeds, if not used in moderation, are purgative.

Other: A nut of great promise for the hot, humid tropics. Selected, high-quality varieties are badly needed.

Prickly Pear

Names: *Opuntia spp.*, as follows: prickly pear, tuna, nopal.

Principal use: The fruits as food.

Brief description: Shrubby to tree-like desert plants with stems modified as pads, leaves non-existent or small and temporary, abundant spines and spiny fruits.

Climatic adaptation: Adapted to arid regions and desert soils of the temperate and tropical zones.

Yields: Food: The principal food uses are: 1. the young pads, scraped clean of spines and cooked; 2. the young, green fruits, cooked; 3. the ripe fruits used in many ways: 4. the seeds as ground meal.

Feed: 5. Occasionally, the pads are used as feed after burning off the spines.

Principal species and their sources and uses: *O. azurea*, Mexico, 2; *O. basilaris*, SW USA, 1,2,3; *O. basiliiana*, SW USA, 2; *O. bigelovii*, SW USA, 5; *O. camanchica*, SW USA, 3; *O. clavata*, SW USA, 1, 3; *O. dillenii*, Florida and Caribbean, 1,3; *O. engelmannii*, SW USA, 1,3; *O. ficus-indica* (includes excellent selections), world, 1,3; *O. humifusa*, SW USA, 3; *O. leucotricha*, Mexico, 3; *O. megacantha* (includes excellent cultivars), Mexico, 1,3; *O. phaeacantha*, SW USA, 1,3,4; *O. polyacantha*, SW USA, 1,3; *O. pottsii*, SW USA, juice from boiled stems in cooking; *O. robusta*, Mexico, 1,3; *O. streptacantha*, Mexico, 1,3; *O. tenuispina*, SW USA, 3; *O. tomentosa*, Mexico, 3; *O. tuna*, Mexico, 1,3; *O. versicolor*, SW USA, 3; *O. vulgaris*, Mexico, 1,3.

Suitability for special purposes:

Living fence: Excellent. Useful fences are very easy to establish.

Hedge: A common use.

Erosion control: Very good for rapid protection of desert lands.

Alley cropping: Some species might be useful for alley cropping systems in the desert.

Animal shelter: Animals find shelter in the spiny plants and eat the fruits.

Fiber: A crude fiber of many uses can be extracted from the plants.

Culture: Easily grown from seeds. Also planted from pads or even immature fruits.

Special problems: Sometimes weedy.

Toxic characteristics: Animals are injured by the spines on eating the pads. The seeds of some species might be poisonous. Young pads contain too much oxalic acid.

Other: It is often very difficult to obtain selected varieties.

Prickly Sesban

Names: *Sesbania bispinosa* (*S. aculeata*), prickly sesban.

Principal use: Source of an edible gum for use in food products.

Brief description: Fast-growing, woody annual leguminous shrub, branching or, when crowded, upright to 4 m. Leaves are pinnately compound.

Climatic adaptation: Grows during long, hot summers, tolerates drought, saline, alkaline, poor soil fertility, and, to a lesser extent, excess water.

Yields: Food: The gum is extracted from the seeds and is used in foods (as well as industrial products.)

Feed: Young foliage is useful as feed. The seed, after extraction of gum, is a potential source of protein.

Other products: Fiber for weaving and for rope and net making. Pulp for making paper and hardboard. Green manure and mulch. When grown under crowded conditions can produce useful poles for agricultural purposes or light construction.

Suitability for special purposes:

Hedge: Can make a rapid temporary hedge.

Plants for Use in Permaculture in the Tropics

Prickly Sesban, cont....

Erosion control: An effective cover for soil due to its fast growth.

Alley cropping: Has some potential for alley cropping.

Nitrogen fixation: Excellent.

Fuel: Dried woody stems suitable as fuel.

Culture: Planted from seed at the beginning of the rainy season or of lengthening days, grows rapidly, flowers, produces seed, and dies back in about 6 months.

Special problems: Can be weedy.

Toxic characteristics: None reported.

Prosopis

Names: *Prosopis juliflora* (also *P. glandulosa*, *P. pallida*, & *P. ruscifolia*), kiave, mesquite.

Principal use: Forage, especially during dry seasons.

Brief description: Leguminous trees with spreading crown, pinnately compound leaves, small leaflets, spikes of tiny, pale yellow flowers, pods about 29 cm long in clusters, flat or twisted, with a dry sweet pulp surrounding the seed.

Climatic adaptation: Dry, desert-like regions, from sea level to 500 m or more, the various species adapted to different regions.

Yields: Food: The dried pod can be sucked as an emergency food, or extracted for sugar.

Feed: The dried pods are eaten as an important feed during the dry season.

Other products: This plant attracts bees with its abundant flowers.

Suitability for special purposes:

Hedge: Can be grown as an almost impenetrable hedge.

Living trellis: Yes, for the foliage is not too dense.

Shade: Serves as light shade.

Erosion control: Excellent long-term tree for control of erosion.

Earthworks: Very suitable.

Nitrogen fixation: Yes, also very good at mineral recovery from depths.

Lumber: Wood is very hard and useful for furniture and small objects.

Fuel: Makes excellent fuel.

Culture: Grown from seeds. Seeds may need soaking or hot water scarification before planting.

Special problems: Most trees are spiny. Spineless types are known. May be weedy in some climates.

Toxic characteristics: Excess in the diet results in jaw and tongue problems.

Shea Butter Tree

Names: *Butyrospermum paradoxum* subsp. *parkii*, shea butter tree, butterseed.

Principal use: The edible oil extracted from the seed.

Brief Description: Medium-sized tree of the family *Sapotaceae*.

Climatic adaptation: Adapted to desert climates of the tropics.

Yields: Food: Seeds are extracted for the edible oil, used as butter, and cooking oil (exported for this purpose). The pulp of the fruit is also edible.

Other products: The oil is used for numerous purposes.

Suitability for special purposes:

Windbreak: Often used as a windbreak.

Shade: A useful shade tree.

Erosion control: Used for this purpose and as a source of mulch.

Nitrogen fixation: Although not a legume, said to fix nitrogen.

Lumber: A minor source of timber, the wood is used to carve useful objects.

Fuel: Makes good firewood and charcoal.

Culture: Wild in Africa, cultivated in West Africa and the Sudan. Planted from seeds.

Other: The species has a number of medicinal uses.

Soybean

Names: *Glycine max*, soybean, soy bean, soya.

Principal use: As a highly nutritious, versatile pulse.

Plants for Use in Permaculture in the Tropics

Soybean, cont....

Brief description: Annual leguminous herb with trifoliate leaves and small insignificant flowers, followed by short, pea-like pods of several slightly flattened seeds. Soy beans flower in response to length of day. Therefore, size of plant before flowering depends on the latitude, season of the year, and variety.

Justification in a permaculture system: The soybean is a unique crop. The bean is so nutritious (very high in protein, high oil) and highly versatile that it would be a crime to neglect it. It is hard on the soil and requires extra fertilization and erosion control. The challenge is to find methods of including it in permaculture systems.

Climatic adaptation: Adapted to hot weather. Needs moisture to germinate and grow, but needs dry weather during the maturation of seeds. Flowers during short days.

Yields: Food: Green, immature seeds cooked as a shelled pea. Dried seeds cooked as a pulse (dried bean) or used to make soybean milk, tofu (cheese), or tempeh (fermented product). Dried seeds can be extracted for edible oil and for protein concentrate.

Feed: The green plants are relished by animals. The dried plants are of some value as hay. The dried seeds are crushed and used as a principal ingredient of many animal feeds.

Other products: Soybeans have numerous industrial uses.

Culture: Soybean seeds must be thoroughly dried and stored at a low temperature. In some areas, the seed must be treated with a specific *Rhizobium* inoculant. The seeds are sown about 2.5 cm deep, in rows about 35 cm apart, 10 cm apart in the row. Season of planting is very important to take advantage of soil moisture, to accommodate the variety to the right day length, and to mature the plants during a dry season. Plants are fast-growing but may need some fertilization. Following flowering, the pods develop rapidly and may be harvested for the shelled bean when mature, but before they dry. When the plants die, they can be threshed in the field. Supplementary drying of the seeds may be necessary.

Toxic characteristics: Uncooked seeds contain some antinutrients. When seeds are grown and dried under wet conditions, they may contain poisonous products of fungi.

Other: Special cooking methods are necessary for soybean, and to prepare the special products that are possible. Soybean cookery is a special art to be learned.

Sweet Potato

Names: *Ipomoea batatas*, sweet potato, camote.

Principal use: Edible, starchy, tuberous root.

Brief description: Perennial trailing vine usually grown as an annual, producing tender vine tips and edible roots. The vines are thick-stemmed, short to long internodes, and rooting readily at the nodes. Leaves are heart-shaped with various degrees of lobing. The edible root is often spindle-shaped, or of various sizes, internal and external color. Orange-fleshed roots are rich in carotene.

Climatic adaptation: Sweet potatoes need a hot, sunny climate for adequate growth. Planted on a wide variety of fertile or fertilized soils, they do not tolerate flooding but will tolerate some drought after well rooted, or in the second half of the life cycle. Can be grown year round.

Yields: Food: The fleshy root boiled, or baked, or baked into bread. Also processed into flour or starch.

Feed: Most farm animals relish all parts of the plant.

Other products: The starch is used industrially and can be fermented to alcohol.

Suitability for special purposes:

Shade: When trained over a trellis.

Erosion control: Will cover loose soil rapidly during summer months.

Culture: Sweet potatoes are planted from healthy cuttings during times of adequate water availability. Cuttings can come from stored roots or from plants maintained for that purpose. A 30-40 cm cutting is planted 2/3 below the soil surface and watered frequently until established. Fertilizer requirements are modest and depend on soil and variety. When plants are rapidly growing, tips may be harvested as spinach. Edible root production requires 3-5 months. Insects and disease are best controlled by the use of clean cuttings, rotation of crops, and avoidance of old plantings and plant residues.

Special problems: The sweet potato weevil or other pests may make production very difficult in some areas.

Toxic characteristics: Sweet potatoes contain trypsin inhibitor and must be cooked. Insect-infested and diseased tuberous roots may be poisonous, and should be carefully trimmed before eating. Discard discolored areas that appear on cooking.

Tahitian Chestnut

Names: *Inocarpus edulis*, Polynesian chestnut, Tahitian chestnut.

Principal use: The large seed as a cooked food.

Brief description: Large, leguminous tree with simple, alternate leaves, clusters of small flowers and large, single-seeded pods.

Climatic adaptation: Widely adapted in the hot tropics, especially the humid tropics, tolerates many soils, including some salinity.

Plants for Use in Permaculture in the Tropics

Tahitia Chestnut, cont....

Yields: Food: The seed is difficult to remove from the large, fleshy pod. It is eaten raw, or after boiling or roasting in the pod.
Feed: The foliage is used as fodder. Pigs eat the pods.

Suitability for special purposes:

Shade: A good shade tree.

Nitrogen fixation: Yes.

Lumber: Makes a fair grade of lumber.

Fuel: The wood makes a good fuel.

Culture: Planted from seeds.

Other: This is an important source of food in some islands of the South Pacific. It probably will be very useful elsewhere. It needs introduction and study. A major defect will be its eventual large size.

Tamarind

Names: *Tamarindus indica*, tamarind.

Principal use: The sour pulp around the dried seed has numerous food uses.

Brief description: Medium to large spreading tree with pinnately compound leaves bearing large quantities of rusty green immature pods, rusty brown and thick when mature, with easily broken shell and a sour brown pulp around the seeds.

Climatic adaptation: Adapted to hot savanna and dry-land forest, or monsoon climates with a pronounced dry season, from sealevel to less than 1,000 m, tolerant of coastal climate and drought, but not to flooding of roots or very long wet season.

Yields: Food: Young leaves, flowers, and small pods are cooked as vegetables, dry pulp is eaten out of hand, used as a food additive or for drinks.

Feed: Foliage is used as feed, ground seed as livestock feed.

Other products: The pulp has many commercial uses, such as Worcestershire sauce.

Suitability for special purposes:

Barrier plant: A good barrier plant because of its size.

Windbreak: Old trees make excellent windbreaks.

Shade: Excellent.

Animal shelter: Good home for birds.

Nitrogen fixation: Yes, and retrieves deep nutrients as well.

Lumber: The lumber is very good, used in paneling and furniture.

Fuel: Good.

Culture: Seeds are slow to germinate and may need scarification. A light, well-drained soil is good for early growth. Later, the tree can withstand heavier soils. Can be grafted when young. Slow growing.

Special problems: When mature, the tree is too large for a small farm. It can be pruned, however.

Toxic characteristics: Contains large amounts of tartaric acid, which can disturb digestion if eaten in quantity. Can be purgative.

Other: There are numerous medicinal uses for the tree. The root is used in tanning. The ripe fruit is used to polish copper and brass.

Taro, Dasheen, and Eddoe

Names: *Colocasia esculenta*, taro, dasheen, and eddoe.

Principal use: As cooked, starchy staple vegetables.

Brief description: A central plant consisting of basal corm from which radiate petioles bearing large, heart-shaped leaves, petiole joining the leaf at the blade, not at the crotch between the lobes. The botanical varieties differ in the degree of production of corms at the side of the principal corm.

Climatic adaptation: Hot, humid conditions during a long growing season. The varieties differ in the amount of water needed, and time to maturation.

Yields: Food: The principal corm or corms developed at the side cooked by peeling and boiling or baking, or grated and fermented, or dried and ground as flour. The unfurled green leaf of some varieties can be cooked as a green. The petiole of a few varieties is cooked as a vegetable.

Feed: The corm is often eaten by farm animals.

Other products: The starch can be extracted and used for many purposes.

Suitability for special purposes:

Erosion control: Some varieties can be used as a quick and temporary ground cover in the rainy season.

Alley cropping: Some varieties are used in multiple cropping systems.

Plants for Use in Permaculture in the Tropics

Taro, etc., cont....

Culture: Planted from the tops of the corms or from pieces of the corm, or from the small side corms. The varieties differ in whether they require paddy or non-paddy (upland) conditions.

Toxic characteristics: All plant parts contain some calcium oxalate crystals. All need cooking or other processing before eating.

Other: Taro is one of the great foods of the Pacific. Dasheen and eddoe are preferred in most other parts of the world.

Tropical Lima Beans

Names: *Phaseolus lunatus*, lima bean, sieva bean.

Principal use: Mature seed as a pulse.

Brief description: Tropical varieties are invariably climbing vines, with leaf of three leaflets, small flowers, clusters of pods, and many-colored seeds.

Climatic adaptation: The varieties are adapted to different regions of the tropics, often disease-resistant and productive.

Yields: Food: Young, green pods, mature green seeds, and mature dried seeds as cooked food.

Feed: Can be used cautiously as feed.

Suitability for special purposes:

Erosion control: A good, rapidly growing temporary cover.

Nitrogen fixation: Yes. Useful as a green manure crop.

Culture: Planted from seed during spring and summer months, needs trellis for good production.

Toxic characteristics: The foliage may contain glycosides of hydrocyanic acids. Precautions are necessary in using this species as feed.

Other: Tropical varieties are hardly developed, but are great sources of food. Varietal trials are desirable.

Tropical Pumpkin

Names: *Cucurbita moschata*, tropical pumpkin, calabaza.

Principal use: As a squash-type, high vitamin-A vegetable.

Brief description: Weakly perennial trailing or climbing vine, often reseeding itself, rooting at the nodes, with large (1 ft diameter) leaves, large yellow flowers that are either male or female, a firm-skinned, mottled brown fruit, spherical or pear shaped, with thick yellow flesh, and a cavity with several hundred flat seeds.

Climatic adaptation: Adapted, more so than any other type of squash, to the hot tropics, very tolerant of heavy soils and excess rainfall as well as occasional flooding, preferring rich growing conditions but still growing and producing something edible under poor conditions and some drought.

Yields: Food: The easiest and most abundant food is produced from tips of the vigorous branches, cooked as a green vegetable. The male flowers and flower buds, the young immature fruits, and the mature fruits also are cooked as vegetables. Seeds are eaten raw or toasted, or ground as a meal.

Other products: The seeds can be extracted by pressure, grinding and gentle warming or with solvents for their oil.

Suitability for special purposes:

Shade: Grown on a trellis, tropical pumpkin provides temporary shade.

Erosion control: Makes a fair and rapid ground cover.

Alley cropping: Can be grown very well as a crop in the alleys or as a crop within the hedge.

Nitrogen fixation: No.

Multiple cropping: Very dominant in its growth habits, and thus does not permit companion crops to grow well.

Culture: Normally planted from the abundant and easily-stored seed, but can be easily planted from rooted branches. Needs a richer than normal soil and benefits from abundant moisture. Needs a lot of space, either ground to cover or trees to grow into. Hand pollination of female flowers early in morning increases fruit numbers and size (due to more seeds). The branch tips can be taken regularly, thus pruning the plant and directing its growth. Male flower buds can be harvested at any time. They are always abundant compared to female flowers. The immature fruits are harvested as needed and the brown, mature fruits can be harvested and stored. Occasional insect and disease problems are usually tolerable. Fruiting is poor under sub-optimal conditions.

Toxic characteristics: Bitter forms may contain poisonous cucurbitacins. They should be avoided.

Other: One of the most efficient food producers in the tropics, if fully utilized.

Plants for Use in Permaculture in the Tropics

Umbrella Thorn

Names: *Acacia tortilis*, umbrella thorn.

Principal use: Pods used as forage.

Brief description: Medium-sized, branched, spreading leguminous tree, forming a dense, umbrella-like crown, with pinnately compound leaves, fragrant, small flowers in clusters, and twisted pods.

Climatic adaptation: Adapted to very hot, dry climates including alkaline and sandy, rocky soil. Tolerates wetter climates as well.

Yields: Feed: The pods are available during the driest season when other forages are unavailable. Foliage is also edible.

Other products: Excellent fuel or charcoal. Useful wood.

Suitability for special purposes:

Hedge: Can be used in this fashion.

Living trellis: Gives light shade and support for climbing crops.

Shade: A welcome light shade in the desert.

Erosion control: Useful to reforest and to stabilize desert soils.

Nitrogen fixation: Good source of nitrogen and deep minerals.

Lumber: Wood dense, useful for small articles.

Fuel: An excellent fuel.

Culture: Seeds germinate spontaneously in disturbed areas. Easy to grow from seeds, but the growth is slow.

Special problems: The thorns can be a problem to animals and people.

Toxic characteristics: Foliage might be toxic in large amounts.

Other: Pods are susceptible to insect attack.

Winged Bean

Names: *Psophocarpus tetragonolobus*, winged bean, Goa bean.

Principal use: As a high-quality snap bean.

Brief description: Annual or weakly perennial twining vines with usually bluish flowers and a large pod, flat or square, with four lateral ridges or wings, round seeds.

Climatic adaptation: The hot, humid tropics, tolerant of very rainy conditions. Most varieties bloom during short days. There are a few day-neutral varieties.

Yields: Food: The small, green pod can be eaten raw. The half-grown pod is cooked as a vegetable, and the fully mature but not green seeds can be used as shelled peas. The dried seeds can be softened and eaten. The leaves, flowers, and tuberous roots of some varieties are also eaten.

Feed: The foliage is readily eaten by farm animals.

Suitability for special purposes:

Shade: Makes a good temporary shade when grown on a trellis.

Alley cropping: Useful in alley cropping grown on a nurse tree or trellis.

Nitrogen fixation: Yes.

Culture: The seeds must be nicked with a knife to promote germination. They are planted at the beginning of the rainy season. The young plants may need some support as they are fragile at first. Adequate watering is very important. Best yields are obtained by trellising and by frequent harvest of young pods.

Special problems: The hard seeds are difficult to use. This is overcome by boiling seeds for three minutes with a teaspoon of sodium bicarbonate, letting stand overnight, then discarding the water, rinsing, and cooking for 20 minutes.

Toxic characteristics: Seeds have several antinutrients or toxic substances and always must be cooked.

Other: Not a miracle crop, as once thought, but an excellent, high-protein snap bean.

Yams

Names: *Dioscorea alata* and *D. rotundata* (and others), yams, not related to sweet potatoes.

Principal use: As excellent starchy staple foods with good contents of protein and vitamin C as well.

Brief description: Twining vines with heart-shaped leaves and parallel veins, producing underground (and, in some cases, aerial) tubers during fall months.

Climatic adaptation: Adapted to the hot, humid tropics, or the monsoon type climate.

Yields: Food: The tuber, boiled, baked, or fried, or extracted for starch, or dried and ground into flour.

Feed: Animals will eat the raw tuber and sometimes show digestive problems. The tuber should be cooked.

Other products: Some species of yam are commercial sources of cortisone precursors.

Plants for Use in Permaculture in the Tropics

Yams, cont....

Suitability for special purposes:

Shade: Excellent summer shade when grown over trellises.

Erosion control: Some varieties are useful for temporary, dense ground covers, and will root at the nodes.

Culture: Yams are planted from fist-sized pieces of the tuber, usually during spring months, but as natural sprouting begins. These pieces are dried a few days after cutting them. The soil should be rich in organic material. Trellises are provided for the climbing vines. Yams are harvested after the foliage dies back (during short days). They can be stored up to 3-4 months.

Toxic characteristics: Some species of yams are poisonous. Good identification is appropriate.

Other: A great potential food on the small farm, but available only during a short part of the year.

Yeheb

Names: *Cordeauxia edulis*, yeheb, jebbeb, geeb.

Principal use: A high-quality, edible leguminous seed for the very dry tropics and subtropics.

Brief description: Perennial shrub up to 3 m high with pinnately compound leaves, small clusters of flowers coming after the rains, followed by pods.

Climatic adaptation: Adapted to the very dry desert with annual rainfall of 250-400 mm (10-15 inches). Tolerant of sandy and alkaline soils.

Yields: Food: The immature seed is eaten raw, a questionable practice. The dried seed can be used at maturity or stored and then is boiled or roasted. The leaves are used to make tea.

Feed: The young shoots, foliage, and pods are grazed.

Other products: A dye is obtained from the bark.

Suitability for special purposes:

Hedge: Makes an excellent hedge.

Windbreak: Makes a good, but low, windbreak.

Shade: The shade provided is little but good for small animals in the desert.

Erosion control: An excellent plant for erosion control in a climate where few exist.

Alley cropping: Can be used in alley cropping.

Nitrogen fixation: Yes.

Fuel: Often destroyed by cutting for fuel. Really, it is too valuable to use in this way.

Culture: Planted from seeds (See note below.) or from transplanted seedlings. May need some watering until well established.

Special problems: The seeds are said to be short-lived. However, this could be only a form of seed dormancy and scarification may be necessary. Tests are needed.

Toxic characteristics: Raw seeds contain a trypsin inhibitor and possibly other antinutrients, inactivated by cooking.

Other: Obtaining seeds for trial is a major obstacle.

ECHO DEMONSTRATION CENTER, N. FT. MYERS FL USA



Editor's Comments

Inga edulis

Inga edulis, the ice cream bean, has proven to be of great value in retaining fertility of soil after cutting of tropical rainforests. *I. edulis* trees are sown, for example, as alley crop, and slashed to provide fertilizer/mulch for the crop. Soil nutrients, in particular phosphorous, are taken up by the deeply foraging tree roots. Most plants cannot recover these deep nutrients, lost to surface soils by leaching. Without *I. edulis* as a 'nutrient pump', many tropical soils are unlikely to retain a useful level of fertility for more than three years.

Cowpea

In addition to functions described by Dr. Martin, cowpea is an excellent smother crop, in many only slightly inferior to *Mucuna* (Florida velvet bean). As a green manure crop, cowpea is one of the few that will yield in a net-gain of nitrogen, even if the seeds are harvested, e.g., for food. This is especially important in subsistence farming where it is very difficult to give up short term food yields for eventual gains in soil fertility, thence higher yields later.

VELVET BEAN AND COWPEA



Mixed velvet bean and cowpea, as a smother-crop, almost completely suppress rampant grasses in a previously uncultivated plot. Wheat will be broadcast into these plants, which will be mowed to cover the wheat seed. Wheat grows during the cool, dry winter season here at Barking Frogs Permaculture Center.

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- Sword Bean.** (*Canavalia gladiata*)
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Thatch.

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Jackfruit, p. 27.

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Tree Tomato.

Tomato. (*Lycopersicon esculentum*)

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(*Cyphomandra betacea*)

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rotundata, et al.), p. 41.

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(*Pachyrrhizus* spp.)

In food crops table, p. 4.

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edulis), p. 42.

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Yucca elephantipes.

See Bulbstem Yucca.

***Yucca* spp.** See Izote.

THE INTERNATIONAL PERMACULTURE SOLUTIONS JOURNAL

P.O. Box 69, Sparr FL 32192-0089 USA

Yankeeperm@aol.com

www.barkingfrogspermaculture.org

Dan Hemenway, Editor & Publisher Cynthia Hemenway, CNM, Associate Editor

Robert Waldrop, Managing Editor

*A journal on the leading edge of permaculture
to provide practical ideas and tools to live in harmony with the Earth.*

Many of us are painfully aware of the severity of catastrophic ecological decline worldwide. The *International Permaculture Solutions Journal* delivers information, ideas and discussion to provide Earth-healing tools or to promote their development. Information that is practical, detailed and hard to find elsewhere often turns up on "TIPS" pages. TIPS is now available as a PDF file on CD. Each volume is about 100 pages. Offprints of recent issues are available. Check our web site for details of price and availability.

Who Writes for TIPS?

Many TIPS writers are tops in the movement: Bill Mollison, Jim Duke, Bill McLarney, and our editor Dan Hemenway, for example. Others are people who have been quietly working on their own. They all have something important to say.

What Does TIPS Cover?

TIPS issues often follow a specific theme. Presently we have a series of issues on aspects of developing sustainable food systems. After that will be a series on "Permaculture Design: The Process and the Product," and then a series on appropriate technology in permaculture. And of course each issue contains articles outside the theme as well--matters too important to wait. Eclectic book reviews, fascinating letters to the editor, informative illustrations, & easy-to-use format are hallmarks of our publication.

A Yankee Permaculture Publication.

TROPICAL 'PUMPKIN'



Appendix I: Resources for Tropical Permaculture

The following 74 resources have been selected from the database of **TRIP -- The Resources of International Permaculture**, a print and computer disk publication of Yankee Permaculture. While there will be many more resources, particularly within specific tropical regions, this list represents a useful starting point. Appendix I supplements this publication with places and people who can provide input and resources on tropical permaculture, tropical agroforestry, and related subjects in the form of information, training and propagation materials. To avoid reproducing essentially the entire tropical component of **TRIP**, we have strongly skewed our selection to include groups concerned mainly with tropical food plants. Other equally vital themes, such as animal husbandry, water supply and storage, appropriate

shelter, energy conservation, generation and storage, alternative economics, and so forth have been slighted. See the complete **TRIP** for a more balanced set of resources for tropical permaculture.

Doubtless, not every one of these resources will be at the address below by the time that you contact it. Please notify us of defunct addresses, address changes, and other information changes so that we may more effectively update future issues. Likewise, your nominations for additions to this Appendix will be gratefully considered. Send your feedback to Dan Hemenway, Editor, Yankee Permaculture, P.O. Box 69, Sparr FL 32102-0069 USA.

Email: YankeePerm@aol.com

APICA

B. P. 5946

Douala Akwa CAMEROON

Distributes shade-tolerant forest vegetables via cuttings.

Keyword List: Gardening.

Tropical Agriculture.

Sustainable Agriculture and Self Help - SASH

POB 5157

Bamenda CAMEROON

Training in agroforestry for women.

Keyword List: Training. Education.

Agroforestry. Women.

ILRI

Dr. J. Hanson

POB 5689

Addis Abeba ETHIOPIA Works with quality legume, browse & grass seed. Formerly listed as ILCA. Small quantities of forage germplasm available from the in trust collection. Seed request forms available from above address.

Keyword List: Legumes. Seeds.

Feed. Genetic Resources.

Conservation. Genetic diversity.

International. Organization. Video.

<http://www.cgiar.org/ilri/>

J.Hanson@cgiar.org

Baobab Trust

C/o Dr. R. D. Haller

POB 10587

Mombasa, Coast 80101

Banburi KENYA

Farmer training workshops.

Keyword List: Training. Education.

Nursery. Livestock. Farming.

www.baobabfarm.com

Baraka Agricultural Training College

POB 52

Molo KENYA

Offers programs in sustainable agriculture.

Keyword List: Training. Education.

Engineering. Animal husbandry.

Sustainable Agriculture.

Kenya Forestry Seed Centre

Kenya Forestry Research Institute

Attn.: C. K. Kiriinya

POB 20412

Nairobi KENYA

Keyword List: Rain Forests.

Tropical. Neem.

Kenya Institute for Organic Farming - KIOF

POB 34972

Nairobi KENYA

"KIOF staff visit farmers' groups in the field, demonstrating the methods and following up with later visits.

Exchange visits between groups are arranged. Successful farmers from the groups were initially enrolled as paid 'promoters' to encourage training in their areas and recruit new members. After progress has been assured, the promoter may be moved to another area. To date,

there are about 100 groups comprising some 3,000 farmers."

Keyword List: Education. Training.

Agroforestry. Botanicals. Tropical agriculture. Organic. Farming.

Community Based.

Manor House Agricultural Center - MHAC

Private Bag

Kitale KENYA

Offers two-year certificate course on growing vegetables biointensively.

Also short courses.

Keyword List: Training. Education.

Biological. Pest. Agroforestry.

Biointensive.

World Agroforestry Centre, International Centre for Research in Agroforestry - ICRAF

POB 30677-00100 GPO

Nairobi KENYA

Formerly listed as International Centre for Research in Agroforestry - ICRAF

"Our goal is to mitigate tropical deforestation, land depletion and rural poverty through improved agroforestry systems." Publication *Agroforestry Today* suspended indefinitely.

Keyword List: Tree Crops. Tropical.

Training. Education. Agroforestry.

Soil Conservation.

<http://www.cgiar.org/icraf>

www.worldagroforestrycentre.org

icraf@cgiar.org

Plants for Use in Permaculture in the Tropics

IITA, Genetic Resources Unit PMB 5320

Ibadan Oyo State NIGERIA
Collects & conserves major African food crops. "Researches stable farming systems for the humid and sub-humid tropics and increased yields of tropical staples such as rice, maize, cassava, sweet potato, yam, cocoyam, and cowpea. Develops cultivars of cassava, maize, and soybeans, cowpea, plantain and yam adapted to the diverse environments of Africa."
Keyword List: Biodiversity. Agriculture. Conservation. Crops. Database. Exchange. Genetic Resources. Seeds. Tree Bank. Tropical Agriculture.

Food and Trees for Africa

Jeunesse Park,
POB 2035
Gallo Manor Gauteng 2052
SOUTH AFRICA
"...contributes to a healthy and sustainable quality of life for all through environmental awareness and greening programmes."
Keyword List: Permaculture. Trees. Agroforestry. Education. Reforestation. Teaching. Community based. Community Gardens. database. environment. forestry. newsletter. Grass Roots.
www.trees.co.za or
www.eduplant.org.za or
<http://learning.mweb.co.za>

Sustainable Agriculture Network of Uganda - SANU

Environment Alert
POB 11259
Kampala UGANDA
Promotes sustainable agriculture "through accessing relevant external information, and through lobbying and advocacy."
Keyword List: Sustainable Agriculture. Tropical Agriculture. Organic Farming. Biodiversity. Lobby. Community Supported Agriculture. Remineralization. Indigenous. Library.

www.enviralert.org
izake@envalert.org

Flame Tree Farm Training Centre

POB 11812
Chingola ZAMBIA
Keyword List: Training. Education. Agroforestry. Livestock.

Fambidzanai Permaculture Training Centre

Ground Cover Journal
Dovedale Rd,
Mount Hampden POB CY
301 Causeway ZIMBABWE
"We are a training and demonstration center for permaculture and other alternative techniques for sustainable development."
Keyword List: Permaculture. training. Agriculture. Appropriate Technology. Biological Controls. Environment. Gardening. Herbs. Holistic. Information Exchange. Ngo. Rain Harvesting. Sustainable Agriculture. Vermiculture.

Zimbabwe Institute for Permaculture - ZIP

Attn: Mrs CS Mgwerume
PO Box 8515
Causeway Harare ZIMBABWE
Keyword List: Permaculture.

Agricultural Development Agencies in Bangladesh

Road 46A/6A
Dhanmondi Dhaka-1 BANGLADESH
Publishes a newsletter.
Keyword List: Agriculture. Development.

University of Tropical Agriculture

Royal University of Agriculture
Chamcar Daung
Phnom Penh 3 CAMBODIA
Keyword List: Tropical Agriculture.
<http://www.cipav.org.co/lrrd> -
regpreston@utafoundation.org

Bamboo Information Centre

Mrs. Zhang Zinping,
Chinese Academy of Forestry

Wan Shou Shan

Beijing 100091 CHINA
Publishes journals and books on forests, Bamboo Abstracts from 1988 to the present (2 issues per year), and provides a bamboo products service for trade outside China.

Keyword List: Bamboo. Computer Network. Education. Health. Journal. Land Use. Resource Management. Training. Weaving.

China Bamboo Society

Subtropical Forest Research Inst.,
CAF Fuyang Zhejiang 311400
CHINA
Keyword List: Bamboo.

International Network for Bamboo and Rattan - INBAR

Branch Box 155 P. O. Box
9799 Beijing 100101 CHINA
Keyword List: Bamboo. Economics. Development. Industrial Materials. Cottage Industries. Crafts.
www.inbar.org.cn

Bepha Bulletin: In the Service of Natural Drugs

Bharat Vinca
Publishers Dhavalganga,
9/E, 1 Carter Rd.
Banda (West) Bombay 400 050
INDIA
Keyword List: Health.

Honey Bee

Centre for Management in Agriculture
Indian Inst. of Management
Vastrapur Ahmedabad 380 015
INDIA
"An informal newsletter for documentation and experimentation of local innovations developed by farmers, pastoralists, artisans, horticulturists, men and women." For sample copy pl visit our web site.
Keyword List: Tropical Agriculture. Journal. Indigenous Knowledge.
<http://csf.colordao.edu/sristi/> -
http://www.sristi.org/cms/honeybee_newsletter

Plants for Use in Permaculture in the Tropics

Association for Propagation of Indigenous Genetic Resources

Samvardhan-APIGR, Aurobindo Society
Vastrapur Talavadi D-1
Ahmedabad 380 015 INDIA
Keyword List: Genetic Resources,

Bamboo Society of India

c/o N. S. Adkoli 23-24 Mezzanine Fl.
Jayanager Shopping Complex
Bangalore 560 011 INDIA
Keyword List: Bamboo.

Central Plantation Crops Research Institute

Kasaragod
Kerala 671 124 INDIA
"bacterial biofertilizers for non-legumes, vermicomposting, biocontrol, green manuring and related subjects."
Keyword List: Fertilizer.
Vermiculture. Biological Controls.
Green Manure.
prabhucochin@yahoo.com

Development Alternatives

Development Alternatives Newsletter
22 Palam Marg. Vasant Vihar
New Delhi 110 057 INDIA
Keyword List:
Sustainable Development
Environment Technology Design.
Shelter.
www.deval.org

International Crops Research Institute for the Semi-Arid Tropics

Patancheru PO
Andhra Pradesh 502 324 INDIA
"Researches crops for the drought-prone portions of the developing world, including groundnuts, chickpeas, pigeon peas, pearl millet, and sorghum."
Keyword List: Tropical Agriculture. Research. Drylands.

National Tree Growers' Cooperative

Attn: M. Wilson
Anand 388 001 INDIA
Keyword List: Agroforestry. Biogas. Cooperatives. Communication.

Ecosystems. Forestry. Grazing. Holistic. Reforestation. Regeneration. Resource Management. Reforestation. Regeneration. Sustainable Development.

Permaculture Punjab

c/o T. Tosh Kasliwai
504 Sector 11B Chandigarh INDIA
Keyword List: Permaculture

Indonesian Bamboo Society

c/o Anang Sumarna
Jalan Raya Cibeureum 16
Bandung 40104 INDONESIA
Keyword List: Bamboo.

Organic Matters

SNV - Netherlands Development Organization
DAPO Box 7463
Pasay City Metro Manila 1300 PHILIPPINES
Keyword List: Organic. Agriculture. Agroforestry. Community Based. Economics. Resource Management. Organic Farming. Global. Fisheries.

Agroforestry Seed Information Clearing House – AFSICH

Dept. of Agronomy
Univ. of the Philippines at Los Baños
College Laguna 4031 PHILIPPINES
"...collects seed-related information..., maintains a data base on 1) seed sources and availability, 2) seed production/handling technologies, 3) seed/plant characteristics, 4) agencies/organizations/individuals doing seed-related work (seed exchange, trading, etc.), 5) agroforestry pests and diseases, 6) botanical pesticides, 7) indigenous seed practices, produces extension materials..., research..., ...training at the university and on-site...." Many publications. An outstanding resource. –DH

Keyword List: Tree Crops. Tropical. Agroforestry. Seeds. Information Exchange. Conservation. Technology. Sustainable Agriculture. Appropriate Technology. Education. Genetic Diversity.

Genetic Resources. Germplasm. Research. Newsletter. NGOs. Training.

Approtech Asia

Phil. Social Dev. Centre, Ground Fl.
Magallanes cor. Real
Intramuros Manila 1002 PHILIPPINES
Information exchange with 38 south and southeast Asia organizations on technologies in such fields as renewable energy, sustainable agriculture, food processing and water supply.
Keyword List: Information exchange. water supply

Institute of Agroforestry

c/o Dr. Virgilio T. Villancio, Coll. of Forestry and Nat. Res. College of Forestry and Natural ResourcesUP
Los Banos, College Laguna PHILIPPINES
Keyword List: Agroforestry.
villancio@yahoo.com

International Institute for Rural Reconstruction - IIRR

Silang Cavite 4118 PHILIPPINES
Very effective demonstration project, training programs, and outreach.
Keyword List: Training. education. Tropical Agriculture. Demonstration. Extension.

International Rice Research Institute – IRRI

POB 933 Manila PHILIPPINES
"Develops high-yielding, fertilizer-responsive rice varieties." IRRI seed bank contains a great many traditional rice varieties. Programs include training in low-input rice production.
Keyword List: Training. Education. Genetic Resources. Seeds. Seed Bank.

Tropical Resources and Ecosystems Sustainability – TREES

University of the Philippines Los Baños

Plants for Use in Permaculture in the Tropics

College of Forestry and Natural Resources
Laguna PHILIPPINES
Keyword List: Training. Forestry.
trees@laguna.net

Asian Vegetables Research & Development Centre

POB 42Shanhua
Tainan 741 TAIWAN
"...to help improve nutrition, health, employment, and income of the poor in the developing world; to develop environmentally safe and sustainable production technologies that can be adapted by the national agricultural research system (NARS) to improve their national research capacity." Does vegetable variety breeding, maintains a germplasm bank, offers publications, and has developed an international network of programs.

Keyword List: Germplasm.
Genetic Resources. Research.
Breeding. Crops. Seed Bank. Seeds.
Tropical Agriculture. Tropics.
<http://www.avrdc>

World Vegetable Center Learning Center

PO Box 42
Shanhua Tainan 74199 TaiwanROC
Keyword List: Crops. Vegetables.
<http://www.avrdc.org/LC/home.html>
avrdcbox@avrdc.org

Permaculture Research & Training Dept

Vacvina Nguyen Van Gia, Nguyen Van Man
C2B-Thanh Cong Ba Dinh
Hanoi VIETNAM
Keyword List: Permaculture.
Research. Training.
Topical Agriculture

University of Agriculture and Forestry –UAF

Thu Duc
Ho Chi Min City VIETNAM
Keyword List: Tropical Agriculture.

Asociación ANAI

Apartado 170-2070
Sabanilla de Montes de Oca

COSTA RICA
US address also listed. 1176 Bryson City Rd., Franklin, NC 28734. For U.S. tax deductible contribution buttons, write to the USA address.
Keyword List: Tropical agriculture. Agroforestry. Aquaculture.
www.anaicr.org
anaicr@racsa.co.cr

Center for Sustainable Development Studies; School for Field Studies

Apartado 150-4013
Atenas Majuela
COSTA RICA
Keyword List: Agroecology. Agroforestry. Biodiversity. Degree. Ecology. Economics. Ecotourism. Integrated Pest Management. Latin America. Research. Sustainable Agriculture. Sustainable Development.

Centro Agronómico Tropical para la Investigación y Enseñanza - CATIE

Latin American Forest Tree Seed Bank
BSF Turrialba Cartago
CATIE 7170 COSTA RICA
Can be a source of fruit and forest trees and tree seeds.
Keyword List: Tropical. Forests. Trees. Seeds.
Reforestation. Rain Forests. Forest Service. Nursery.
Spanish Language. Subtropical.
www.catie.ac.cr/proyectos/bsf/banco.htm
wvasquez@catie.ac.cr
bsf@catie.ac.cr

New Dawn Farm

Apartado 372
San Isidro de El General
COSTA RICA
Keyword List: training. Agroforestry. Tropics.

Organisation for Tropical Studies

Univ. of Costa Rica
POB 676-2050
1050 San Pedro de Montes de Oca
San Jose COSTA RICA

Keyword List: Training. Education. Sustainable Agriculture. Tropics.
<http://www.ots.ac.cr>
<http://www.ots.duke.edu>

Procacao

IICA
Apdo. 55-2200
Coronado COSTA RICA
Promotes increased returns for cocoa-growing integrated with other crops.
Keyword List: Agroforestry. Companion Planting. Food Systems.

Tropical Science Center

Apartado 8-3870
San Jose 1000 COSTA RICA
Keyword List: Tropics

Assoc. of Consultants for a Sustainable, Ecological & People-Centered Agriculture – COSECHA

Apartado 3486
Tegucigalpa HONDURAS
Keyword List: Training. Education. Tropical Agriculture. Consultancy. Sustainable Agriculture. Ecology. People.

International Cover Crop

Clearinghouse Cover Crop News
Attn: Milton Flores B., CIDICCO
Apartado Postal 3385
Tegucigalpa M.D.C. HONDURAS
Keyword List: Training. Education. Soil. Green Manure.

Information Centre for Low External Input and Sustainable Agriculture – ILEIA

LEISA Magazine
POB 2067
NL-3800 CB Amersfoort Netherlands
Outstanding newsletter! –DH
Keyword List: agroecology, agriculture, biodiversity, development.
Sustainable Agriculture. participatory. technology. development.
Resource Management.
<http://www.ileia.org>
ileia@ileia.nl
w.roem@ileia.nl

Plants for Use in Permaculture in the Tropics

CIMMYT - International Center for Maize & Wheat Improvement

CIMMYT World Wheat Facts and Trends

Lisboa 27 Apdo., Postal 6-641
Mexico D.F. Mexico 06600* MEXICO
Improved varieties of corn and wheat, including "Quality Protein" maize.

Keyword List Crops. Ecosystems. Genetic Diversity. Genetic Resources. Germplasm. Integrated Pest Management. Land Use. Maize. Seeds. Sustainable Agriculture.

International Association for Food Self-Sufficiency

Apdo. Postal 40
Camalu BCN 22910 MEXICO
Keyword List: Tropical Agriculture. Food.

Agroforestry Net

Overstory
POB 428
Holualoa HI 96725 USA
Keyword list: Agroforestry
www.agroforestry.net/overstory

American Bamboo Society – ABS

c/o Michael Bartholomew
750 Krumkill Rd.
Albany NY 12203-5976 USA
Write for addresses of following chapters: Caribbean; Northeast; Northern California; Pacific Northwest; Southeastern; Southern California; Hawaii, Tierra Seca, Louisiana-Gulf-Coast, Oregon, Puerto Rico and Texas.
Keyword List: Bamboo.
<http://www.bamboo.org/abs>
<http://www.bamboo.org/abs/PlantAndProductSources.html>

American Bamboo Society/ IBG
Archive:
<http://home.ease.isoft.com/archives/bamboo.html>

ANAI

US Office
1120 Meadows Rd.
Franklin NC 28734 USA
Costa Rican address also listed.
"ANAI is a small, independent not-

for-profit research, educational and development organization incorporated under the laws of Costa Rica. ANAI, Inc is a not-for-profit organization with the major purpose of facilitating the work of ANAI of Costa Rica. ANAI's diverse projects are united by two beliefs:

1. There is no essential contradiction between economic development and environmental conservation. Rather, if communities and nations are to function properly, development and conservation must work together.

2. The most apt stewards of the tropical lowlands are the small farmers who have committed their lives to them. Whatever helps them helps the lowland environment, and vice versa.

"ANAI's primary role is in the development and establishment of agroforestry and sustainable yield forest management systems for small landholders in some 40 communities. This work is integrated with a full spectrum of activities ranging from traditional conservation in protected areas to small business management training."

For tax purposes, US citizens can contribute through the US office.

This group has our highest recommendation.

Keyword List: Rain Forests. Responsible Development. Agroforestry. Tree crops.

Bamboo of the Americas – BOTA

28446 Hunter Creek Loop
Gold Beach OR 97444 USA
Keyword List: bamboo
<http://www.bambooftheamericas.org>

Center for Subtropical Agroforestry

Sarah W. Workman, School of Forest Resources & Conservation
POB 110831 – UFL
Gainesville FL 32611-0410 USA
Keyword List: Agroforestry.
<http://cstaf.ifas.ufl.edu/>

ECHO (Educational Concerns for Hunger Organization)

EDN (ECHO Development Notes)
17391 Durrance Rd.

N Ft. Myers FL 33917 USA
"ECHO's primary mandate is to strengthen the ministry of [Christian] missionaries and national churches as they work with smallholder farmers or urban gardeners in the Third World [and] others doing similar work such as Peace Corps Volunteers...." ECHO maintains a seed bank of useful plants for tropical and subtropical environments, a demonstration experimental farm, a networking effort to 100+ countries, an intern program, and a publications program. ECHO also hosts an annual Agricultural Missions Conference and an online bookstore at <echonet.org>.

An important resource worthy of support. —DH

Keyword List: Demonstration. Education. Tropics. Gardening. Tropical Agriculture. Agriculture. Seeds. Plants. Genetic Resources. Information Exchange. Seed Bank. Training. Edible Landscaping. Internship. Library.
<http://www.echonet.org>
echo@echonet.org

Elfin Permaculture

Barking Frogs Permaculture Center
POB 69
Sparr FL 32192-0069 USA
Permaculture consulting, lecture & teaching service operated by Dan Hemenway and Cynthia Baxter Hemenway, who also edit this publication. Our annual Permaculture Design Course Online runs six months and is now our major training program. The core of this course is available on CD-ROM.
Keyword List: Advanced. Training. Permaculture. Audio Visuals. Workshops. Internship. Apprenticeship. Education. Computer. Consultancy. Database. Diploma. Certification. Photographs. Road Show. Slides. Teaching.
www.barkingfrogspermaculture.org
barkingfrogspc@aol.com

Plants for Use in Permaculture in the Tropics

Florida Gardens and Preserves Collaborative

C/o Robert Bowden, Harry P. Leu
Botanical Gardens
1920 N Forest Ave.
Orlando FL 32803-1537 USA
Keyword List: Genetic Diversity.
Subtropical.

<http://www.floridaplants.com/flgarden/s/Default.htm>
rbowden@ci.orlando.fl.us

Fruit and Spice Park

24801 S.W. 187 Ave.
Homestead FL 33031 USA
Keyword List: Tree Crops.
<http://www.floridaplants.com/fruit&spice/index.html>
RTropicals@aol.com

International Palm Society
Box 27
Forestville CA 95436 USA
Keyword List: Agroforestry. Trees.

Leaf for Life

C/o David Kennedy
260 Radford Hollow Rd.
Big Hill KY 40405 USA
Promotes leaf protein.
Keyword List: Food Systems.
Nutrition.

Neem Association
4218 Key Biscayne Ln. #118
Winter Park FL 32789 USA
Keyword List:Neem. Agroecology.
Economics.
Sustainable Development.
Tree Crops. Tropical Agriculture.

Agricultural Development in the America Pacific – ADAP

Pacific Islands Farm Manual
Ag. Instructional Materials Svc.,
Tropical Energy House
Univ. of Hawaii
Honolulu HI 96822 USA
Keyword List: Tropical Agriculture.
Sustainable Development.

International Bamboo Foundation – Maui

POB 868
Paia HI 96779 USA
Keyword List: Bamboo.
<http://bamboocentral.org>

La'akea Gardens
POB 1178
Pahoa HI 96778 USA
Permaculture teaching.
programs@permaculture-hawaii.com
Keyword List: Permaculture.
Deep Ecology. Sustainability.
www.permaculture-hawaii.com

National Tropical Botanical Garden

3530 Papalina Rd.
Kalaheo HI 96741
USA
Previously listed as the Hawaii Plant Conservation Center, apparently discontinued as such.
Keyword List: Tropical. Plants.
www.ntbg.org
members@ntbg.org

NifTAL Project

1000 Holomua Ave.
Paia, Maui HI 96779-9744 USA

Nitrogen Fixation by Tropical Agricultural Legumes. Training in production of nitrogen-fixing bacteria.
Keyword List: Training. Education.
Nitrogen fixing. Inoculant. Soil
Tropical. Agroforestry.

nifTAL@Hawaii.edu

Bambu-Brasil

Caixa Postal 41 Echaporá, SP
CEP 19830-000 BRAZIL
Keyword List: Bamboo.

Rede Brasileira Agroflorestal

Rua Visconde de Pirajá 111
Sala 713, Ipanema 22410-001
BRAZIL
Brazilian Agroforestry Network
Keyword List: Agroecology.
Agroforestry. Earthcare.
Ecosystems. Erosion. Farming.
Grass Roots. Land Use. Library.
Reforestation.

Rainforest Information Center
c/o Doug Ferguson
Casilla 344A
Ulloa y Ramiro Davilos
Quito ECUADOR
Also has a permaculture program.
Keyword List: Rain Forests. Tropical
Permaculture. Agroforestry.

Inst. para Production y Investigacion de la Agricultural Tropical

Attn: Miguel Angel Nunez
Apartado 84
Merida 5101A VENEZUELA
Keyword List: Tropical Agriculture.
Research.

Appendix II -- Some Sources of Planting Material

These sources of plant materials have been selected from the Elfin Permaculture Supplier List, available in digital form. This is merely a beginning list of some sources of some useful tropical plants, including some of those mentioned by Dr. Martin in this publication.

As Dr. Martin suggests, local sources are the first places to look to find regionally adapted varieties of the species he mentions. Neighbors often are generous

Rare Fruit Nursery
Lot 41 Nikko Rd
Warnervale NSW 2259
AUSTRALIA

**Permaculture Mid North Coast
Earthcare Nursery**
5 Young St.
Wauchope NSW 2446
AUSTRALIA

Tree Seed Centre
CSIRO Division of Forest Research
POB 4008, Queen Victoria Ter.
Canberra ACT 2600
AUSTRALIA
High quality seed for pilot projects & research.

Florigan Nursery
Lot 2 Lyppards Rd
Cranbourne VIC 3977
AUSTRALIA

Edible Landscapes Nursery
37 Bangalla St
Torwood QLD 4066
AUSTRALIA

Wongyara Permaculture Nursery
POB 95
Melrose SA 5483
AUSTRALIA

Australian Revegetation Corp.
King Edward Rd.
Osborne Park WA 6017
AUSTRALIA
Offering includes 200 spp. Eucalyptus,
200 spp. Acacia, + grasses & herba-
ceous legumes.

Rainforest Seed Co.
Box 241

San Jose 1017
COSTA RICA

ICRAF
*Multipurpose Tree & Shrub Seed
Directory*
POB 30677
Nairobi
KENYA
Lists sources of seed, inoculants, etc.

Inland & Foreign Trading Co, The
Block 79A, 04-418/420, Indus Rd.
Singapore 0316
SINGAPORE
Cover crop, pasture, grass, ornamentals.

Banana Tree, The
715 Northampton St.
Easton PA 18042
USA
Tropicals. Chocolate, tea, cinnamon, etc.

Salter Tree Farm
Rt. 2
Madison FL 32340
USA
100 species of trees native to US
southeast.

W O Lessard Nursery
19201 SW 248 St.
Homestead FL 33031
USA
Bananas.

The Pepper Gal
POB 23006
Ft Lauderdale FL 33307-3006
USA
Edible & ornamental pepper seeds. 200
varieties.

John Brudy's Rare Plant House

with cuttings, seeds, divisions, grafting wood, and so forth. Generally, mail-order sources are less preferable than local suppliers, regional botanical gardens, arboreta, demonstration plantings and so forth.

Contact details change frequently. Suppliers go out of business, and others enter the trade. We welcome additions and corrections to this list. Please send them to Permaculture Supplier List, P.O. Box 69, Sparr FL 32192-0069 USA.

1832 Amberwood Dr.
Riverview FL 33569-4201
USA

ECHO
17430 Durrance Rd.
N. Ft. Myers FL 33917
USA
Seeds & plants of important tropical
vegetables & fruits. Neem. Cactus.

Our Kids Orchids & Nursery
17229 Phil C. Peters Rd.
Winter Garden FL 34787
USA
Bananas, tropical fruit, supplies.

Jungle Fever
POB 130315
Birmingham AL 35213
USA
Rare tropical and temperate seeds.

Plant Finders of America
c/o Fox
532 Beaumont Ct
Covington KY 41001-3671
USA
Find sources of plants that you seek

American Bamboo Co
345 W 2nd St
Dayton OH 45402
USA

Seed Savers Exchange
203 Rural Av POB 70
Decorah IA 52101
USA
"The Seed Savers Exchange is an or-
ganization of gardeners who are working
together to save heirloom and
endangered vegetable varieties from
extinction. We are particularly interested
in contacting gardeners who are

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presently keeping seed of vegetable varieties that are: family heirlooms; not or no longer in any catalog; garden varieties of Indian, Menonite, Amish, Dunkard, Hutterite or Cajun gardeners; foreign, unusual or mutations; extremely disease- or insect- or drought-resistant; very hardy, of exceptional quality and unique or outstanding. If you are keeping such vegetable seed and would be willing to offer it to other gardeners to keep it from being lost, then please join us as a member of the Seed Savers Exchange."

Native Seeds/SEARCH

2509 N Campbell Ave. #325
Tucson AZ 85719
USA

Rescues traditional varieties grown by Native Americans of the region. Offers seed for sale.

Westwind Seeds

2509 N Campbell Av #139
Tucson AZ 85719
USA

Open-pollinated, drought- & heat-resistant, short-season vegetable, flower & herb seeds.

Seeds of Change

1364 Rufina Cir. #5
Santa Fe NM 87501
USA

Many interesting species and varieties of vegetable seeds.

Deep Diversity

Box 190
Gila NM 88038
USA

1000+ varieties seed, all open-pollinated. 500 varieties of vegetables. Organically grown.

KSA Jojoba

19025 Parthenia St. #200
Northridge CA 91324
USA
Jojoba seed.

J. L. Hudson Seedsman

POB 1058
Redwood City CA 94064
USA
Enormous variety of seeds of many types of plants from all over the world.

Redwood City Seed Co.

POB 361
REDWOOD CITY CA 94064
USA
Heirloom, open-pollinated veg. & herb.

Tradewinds Bamboo Nursery

POB 70
Calpella CA 95418
USA
Bamboo.

Bamboo Shoot, A

1462 Darby Rd.
Sebastopol CA 95472
USA
Bamboo.

Bamboo Sourcing

666 Wagon Rd.
Sebastopol CA 95472
USA
Bamboo.

Tropicals Unlimited

595 Uluhaku St.
Kailua HI 96734
USA
Plants & seeds.

Hawaiian Plant Conservation Center

National Tropical Botanical Garden
A Directory of Sources for Native Hawaiian Plants
POB 340
Lawai, Kauai HI 96765
USA

Floribunda Palms

Box 635
Mt View HI 96771
USA
Many species incl. Pacific exotics.

BAMBOO SHOOT



Bambusa oldhami shoot emerging.

Notes on Names of Plants

Many of us lay-people have been taught that the scientific names for plants are *the* exact way to specify a kind of plant. The common names that we routinely use can be confusing because in different places they often refer to different and unrelated species, we learn. Unfortunately, the scientific names that we may have been taught to be the only exact names for a species are themselves subject to alteration and replacement by the officialdom of science in what appears, to an unwashed lay-person such as myself, to be politics of ego, negotiation, and power much like those in other human spheres, although of less moment. Thus your editors not only have had to verify that the typeset version of this manuscript has all the scientific names correctly spelled, but also that the scientific names themselves are more or less currently in vogue. This matter is not as cut and dried as an editor would like it to be. No doubt some of the official names have changed since we began publication of this document.

In some cases we have changed the scientific names from the original manuscripts based on those used in our references. Where author Franklin Martin has expressed a strong preference, however, we gladly defer. Most of the names in this manuscript are consistent with those contained in *Hortus III*. This text is widely used as an authority on such matters, at least in the United States. It generally includes other, less currently fashionable, scientific names by which a species has been known. While clearly a secondary reference in terms of taxonomy, we have also used *Cornucopia II: A Source Book of Edible Plants* by Stephen Facciola. While not intended as a taxonomic reference, *Cornucopia* serves as a basic current reference for sources of many, if not all, of propagation materials for the species recommended by Dr. Martin in this publication. Finally, as a reference of last resort, we have used *Edible Horticultural Crops* by Clive Hackett and Julie Carolane. These references are listed more fully below.

**Hortus Third: A Concise
Dictionary of Plants
Cultivated in the United
States and Canada.**
Staff of the L.H. Bailey
Hortorium
1976, Cornell University
Macmillan Publishing Co., Inc.
866 Third Ave.
New York NY 10022 USA

**Cornucopia II: A Source
Book of Edible Plants**
Stephen Facciola
1990, Kampong Publications
1870 Sunrise Dr.
Vista Ca 92084 USA
ISBN: 0-9628087

**Edible Horticultural Crops: A
Compendium of Information
on Fruit, Vegetable, Spice
and Nut Species**
Clive Hackett & Julie Carolane
Division of Land Use
Research, CSIRO, Canberra,
Australia, 1982
Academic Press Inc.
111 Fifth Ave.
New York NY 10003 USA
also
Academic Press Australia
CentreCourt, 25-27 Paul St. N
N Ryde NSW 2113
AUSTRALIA
ISBN 0 12 312820 X.

About the Author

Dr. Franklin W. Martin, horticulturist, a native of Utah, maintained his headquarters in Puerto Rico during much of his 40-year career as a researcher and advisor. His principal books are *Edible Leaves of the Tropics*, *Techniques and Plants for the Tropical Subsistence Farm*, *Survival and Subsistence in the Tropics*, *Handbook of Tropical Food Crops*, and *Perennial Edible Fruits of the Tropics*.

An avid gardener as well as a fruit and vegetable collector, his stated goal in horticulture is to learn what he can and to pass it on to others. The current text, which Dr. Martin has donated to permaculture without recompense, is further evidence of that dedication.

Dr. Martin has chosen Lehigh, Florida, USA, for his retirement because of its wholesome and convivial character. He is married to Adiola, from Columbia, and they share three natural and four adopted children.

Credits

Like all Yankee Permaculture publications to date, everyone who has worked on this publication has done so as a volunteer, without recompense. We express our special appreciation to Dr. Franklin Martin for contributing the manuscript and working with us through several stages of editing. Hours of diligent proofreading, tracking down scientific names of plants, and generally compensating for the large deficiencies of the editor/typesetter have been given by Cynthia Baxter Hemenway, despite the demands of her career as a nurse midwife. The typesetter and layout artist has been Dan Hemenway, also the editor. Any errors that you find in the book are likely to have originated with me. Please let us know of them so the next edition can be closer to perfect. Noah Madlin, our intern during this project, has contributed some proofreading and, more important, kept work on our own garden moving along so that we could devote the necessary time to this project. More recently, support for our various projects and our website by Robert Waldrop, food self-reliance activist extraordinary, has freed time here at Barking Frogs for work on this second edition.

To the manuscript provided by Dr. Martin, we have appended information from two of our Yankee Permaculture databases. **TRIP - The Resources of International Permaculture** - is a directory of permaculture-allied groups worldwide. **The Elfin Permaculture Supplier List** (PSL) has been combed for entries which might supply the plant materials mentioned in this book. We are quite sure our selection from the PSL for this text is the barest beginning. We will be most grateful to readers for corrections and additions.

Finally, do let us know if you feel that there are ways to present this information in a more useful format. We have done our best with layout and indexing to make the information you need from this text easily found -- and we are sure that there is room for improvement. The PDF format used for the current CD edition allows easy searches with freeware such as Acrobat Reader from Adobe.

For Mother Earth -- DH



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