

strategies are required. These include: effective national 'access and benefit-sharing' measures, growing from a solid national consultation process and a strategy addressing these issues; policies or guidelines for research institutions, protected areas, and in some cases local communities, to guide research collaborations; and a trust fund or guidelines for distribution of financial benefits to ensure equity and the service of national and local priorities.

See also: **Biodiversity:** Endangered Species of Trees; Plant Diversity in Forests. **Medicinal, Food and Aromatic Plants:** Medicinal and Aromatic Plants: Ethnobotany and Conservation Status; Medicinal Plants and Human Health; Tribal Medicine and Medicinal Plants. **Silviculture:** Managing for Tropical Non-timber Forest Products. **Sustainable Forest Management:** Definitions, Good Practices and Certification.

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Edible Products from the Forest

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Introduction

Forests are one of the major forms of natural landscape and are the most important natural resources of the world. The term 'non-wood forest products' (NWFP) has emerged as an umbrella expression for the vast array of both plant and animal resources other than wood derived from forests or forest tree species. The forests are important not only for their economic utility but they also influence the social and economic life of humankind. Forests are an important source of food; in fact people were dependent mainly on forest collected food when they were wanderers and the concept of cultivating food came in only after people started living in settlements. The cultivation of food items made life much easier for humans, who not only started cultivating food but also cultivated the selected ones they liked more. Thereby the number of plants that were included in the cultivated list was much less than the actual number of edible plants found in the wild. In the modern world people seem to have forgotten that all the edible things being used by them now are actually derivatives of those that used to grow in the wild once upon a time, and they also seem to be unaware

of the fact that many such edible plants still exist in the wild which may be even more valuable and suitable nutritionally than the ones that are being cultivated. However, with increasing awareness of the natural environment people are becoming conscious and many have started exploring the wilds to find more plants that are edible. Eating wild foods has many nutritional benefits and can add another dimension to our diet as well as to our relationship to the natural world. Wild plants are nature's gifts to us and have high concentrations of vitamins, nutrients, and calories to make us strong and healthy. Edible forest products (EFPs) make a particularly important contribution to the nutrition of the tribal and rural poor, who more than others are likely to be dependent on trees for a significant part of their income and food supply. Forest-dwelling hunters and gatherers, the world's 300 million shifting cultivators, and millions of smallholders and landless households living near forests and in the savanna depend on forests for a significant part of their food. Forest foods can offer vital insurance against famine during times of seasonal food shortages or emergencies such as droughts, floods, and wars. It is very common for rural people to depend on forest foods between harvests, i.e., when harvested stocks have been consumed but the next crops are yet to mature. Women in particular count on these resources for supplementary nutrition, emergency foods, and many other important products they need to ensure the nutritional well-being of their families. Forest foods are traditionally used to supplement the staple diet, providing vitamins, minerals, and proteins that are lacking in starch-based cultivated crop food. In the subsequent part of this article various edible products from forests will be described. A few examples have been cited in each case and some data about edible forest products of India have been given in the tables. It was difficult to draw a line between 'wild' and 'forest' because at times these two terms have been used interchangeably. The groups of edible forest products included in this article and issues discussed are indicative only. The names of edible plants and animals listed in the tables or mentioned in the text are by way of an extended example.

Edible Products from the Forests

Any forest produce that can be consumed safely is classified as edible produce of the forest. In recent times wild edible products have gained considerable attention due to their ability to supplement the needs of the changing society. These wild edible products can be classified into various groups and subgroups:

- foods items (fruits and berries, vegetables, roots, rhizomes, bulbs and tubers, nuts, seeds and grains, resins, sap, gums, forest edibles of animal origin, honey, etc.)
- spices and condiments
- beverages
- health foods
- mushrooms
- medicinal plants
- edible oils.

Food Items

Fruits and berries The food items collected most frequently from the wild are fruits and vegetables. Fruits are undoubtedly humanity's oldest food. Before the start of organized agriculture, prehistoric nomads lived on wild game, wild fruits, and berries. When humans took to organized agriculture, they started cultivating grain crops, but surely they grew some fruits in the backyard too. Instead of the many varieties of fruits grown by humans there are still many others that have not yet been domesticated and are still found in the wild. These are the ones that are collected mostly by the forest-dwellers and rural people to supplement their diets, and they are definitely rich sources of many minerals and vitamins. Nutritionally, wild fruits are as rich in vitamins and minerals as cultivated fruits, lower in sugar and calorie content, and free of wax coating, chemical sprays, or artificial ripening agents. And they nearly always taste better than their cultivated counterparts. For example the fruit of baobab (*Adansonia digitata*) far surpasses the orange's famous vitamin C content of 57 mg per 100 g of fruit at 360 mg per 100 g, and one variety of jujube (*Zizyphus jujuba*) reaches levels as high as 1000 mg per 100 g.

In northeast India, which has a rich cover of forests, the locals are still very intimately related to forests and collect enormous amounts of edible fruits from the wild, the knowledge of which has been passed down the generations. For example fruits of wild trees like *Melodinus monogynus*, *Zizyphus mauritiana*, *Phyllanthus emblica*, *Myrica esculenta*, *Elaeagnus conforta*, *Emblica officinalis*, *Elaeagnus umbellate*, *Rubus ellipticus*, *R. niveus*, *R. moluccanus*, etc. are collected and consumed in large quantities. *Zizyphus mauritiana*, *Z. oenoplia*, prickly-pear (*Opuntia dillenii*), Cuddapah almond (*Buchanania lanzan*), Indian black plum (*Syzygium cumini*), Ceylon ironwood (*Manilkara hexandra*), wood apple (*Limonia acidissima*), Indian palm (*Borassus flabellifer*), Manila tamarind (*Pithecellobium dulce*), etc. are some of the common wild fruits used by the ethnic people of

amil Nadu in India. In Blue Creek, Belize the fruits of *Orbigyna cohune*, *Astrocayum mexicanum*, and *Bactris major* are collected from the tropical rainforests and consumed by the local people. Peaches, figs, mulberries, wine berries, chestnuts, ginkgo nuts, and chanterelles are the common wild edibles collected by people in Baltimore. In Ireland wild fruits like pine, hazel, strawberries, blackberries, cranberries, and rosehips are collected. In rural areas of Ethiopia, the most common wild plant fruits consumed are fruits from *Balanites aegyptiaca*, *Ficus* spp., *Carissa edulis*, and *Rosa abyssinica*. The list of wild fruits consumed by various communities can be enormous. The above examples are just indicative. Some more are listed in Table 1.

Vegetables Vegetables are also an important part of the diet and supplement it with various types of vitamins and minerals. They mostly comprise of the leafy parts of a plant, even though flowers and fruits

are also included many times under this list. The vegetables that are collected from the wild include the leaves of trees and shrubs, leaves and twigs of herbs, or even the entire plant. The commonly used wild vegetables in northeastern India are *Amaranthus companulatus*, *Bauhinia variegata*, *Chenopodium album*, *Enhydra fluctuans*, *Ipomea repants*, *Elaeocarpus floribundus*, *Swertia chirayita*, *Parkia roxburghii* etc. *Allium acuminatum*, *Apocynum cannabinum*, *Lewisia rediviva*, *Mentha arvensis*, *Scirpus acutus*, *Clintonia uniflora*, *Typha latifolia*, *Empetrum nigrum*, *Potentilla pacifica*, *Sedum divergens*, etc. are some of the herbaceous plants used by people of western Washington State, USA. Shrubs and trees used by them include *Berberis* spp., *Ribes* spp., *Rubus* spp., *Malus fusca*, *Mabonia* spp., *Prunus emarginata*, etc. *Myrica gale* and Sweet fern (*Comptonia peregrine*) are used as vegetables by people of Canada. In Belize *Sabal mexicana* and *Spondias mombin* are plants found growing abundantly in the rainforests,

Table 1 Names of some frequently collected edible fruit yielding wild plants of India

Sl number	Wild edible plants	Family	Parts used
1	<i>Polygonum chinense</i>	Polygonaceae	Ripe fruits
2	<i>Solanum surattense</i>	Solanaceae	Unripe fruits
3	<i>Ficus glomerata</i>	Moraceae	Fruits
4	<i>Ficus religiosa</i>	Moraceae	Fruits
5	<i>Ficus bengalensis</i>	Moraceae	Fruits
6	<i>Ficus palmata</i>	Moraceae	Fruits
7	<i>Gnetum gnemon</i>	Gnetaceae	Fruits
8	<i>Grewia hirsute</i>	Tiliaceae	Fruits
9	<i>Phyllanthus acidus</i>	Euphorbiaceae	Fruits
10	<i>Calamus erectus</i>	Arecaceae	Fruits
11	<i>Solanum indicum</i>	Solanaceae	Fruits
12	<i>Solanum torvum</i>	Solanaceae	Fruits
13	<i>Solanum nigrum</i>	Solanaceae	Ripe fruits
14	<i>Berberis aristata</i>	Berberidaceae	Fruits
15	<i>Cordia dichotoma</i>	Ehretiaceae	Ripe fruits
16	<i>Pyrus pashia</i>	Rosaceae	Fruits
17	<i>Madhuca butyraceoides</i>	Sapotaceae	Fruits yield butter
18	<i>Zanthoxylum aceanthopodium</i>	Rutaceae	Fruits
19	<i>Dillenia pentagyra</i>	Dilleniaceae	Fruits
20	<i>Bauhinia purpurea</i>	Caesalpinaceae	Fruits
21	<i>Grewia hirsute</i>	Tiliaceae	Fruits
22	<i>Mangifera sylvatica</i>	Anacardiaceae	Unripe fruits
23	<i>Prunus nepalensis</i>	Rosaceae	Fleshy fruit
24	<i>Myrica esculenta</i>	Myristaceae	Fruits
25	<i>Emblica officinalis</i>	Euphorbiaceae	Fruits
26	<i>Elaeagnus umbellata</i>	Elaeagnaceae	Fruits
27	<i>Elaeagnus pyriformis</i>	Elaeagnaceae	Fruits
28	<i>Elaeagnus parviflora</i>	Elaeagnaceae	Fruits
29	<i>Rosa macrophylla</i>	Rosaceae	Fruits
30	<i>Rosa moschata</i>	Rosaceae	Fruits
31	<i>Rubus ellipticus</i>	Rosaceae	Fruits
32	<i>Rubus niveus</i>	Rosaceae	Fruits
33	<i>Prunus armeniaca</i>	Rosaceae	Fruits
34	<i>Prunus communis</i>	Rosaceae	Fruits
35	<i>Prunus persica</i>	Rosaceae	Fruits
36	<i>Holoptelea integrifolia</i>	Ulmaceae	Fruits
37	<i>Madhuca longifolia</i>	Sapotaceae	Fruits

and their shoots and leaves are consumed raw as well as in cooked form. Wild greens (*Portulaca oleracea*), Capper bush (*Capparis zeylanica*), wild bittergourd (*Mimordica dioica*), poison berry (*Solanum indicum*), prickly amaranth (*Amaranthes spinosa*), Indian fig (*Ficus glomerata*), potato yam (*Dioscorea pentaphylla*), wild date palm (*Phoenix sylvestris*), Bermuda buttercup (*Oxalis corniculata*), heart's pea (*Cardiospermum helicacabum*), prickly leaved solanum (*Solanum trilobatum*), adamant creeper (*Cissus quadrangularis*), and mountain ebony (*Bauhinia tomentosa*) are some of the wild vegetables used by the tribals of South India (Tables 2 and 3).

Roots, rhizomes, bulbs, and tubers These are the underground parts, which are usually organs of perennation for the plants. Rhizomes are underground stems which grow beneath the surface of soil;

they are frequently fleshy and serve as organs of food storage. Sometimes the rhizomes are condensed into solid swollen forms which are then known as corms. The tubers are also underground parts, which may either be modified roots or stems. They serve both as an organ of vegetative reproduction and storage organ. Rhizomes and tubers have high contents of carbohydrates, proteins, and minerals and are a very good source of food for humans. They have been used by humans as a source of energy to meet their dietary requirements since times immemorial. Tubers and rhizomes still constitute a significant part of human diet in many parts of the world.

Roots of knotweed (*Polygonum* sp.) and wild ginger (*Asarum canadensis*) are used by the people of Mound City, Ohio, USA. *Boerhavia chinensis*, *Pueraria tuberosa*, *Mauera oblongifolia*, *Dioscorea tomentosa*, *D. oppositifolia*, and *Cyanotis tuberosa*

Table 2 Names of some frequently collected edible vegetative parts yielding wild plants of India

SI number	Wild edible plants	Family	Parts used
1	<i>Cassia tora</i>	Cesalpiniaceae	Leaves and pods
2	<i>Polygonum chinese</i>	Polygonaceae	Leaves
3	<i>Solanum denticulatum</i>	Solanaceae	Leaves cooked
4	<i>Amaranthus spinosus</i>	Amaranthaceae	Young shoot
5	<i>Bambusa</i> spp.	Poaceae	Young shoot
6	<i>Cycas pectinata</i>	Cycadales	Young leaves
7	<i>Euphorbia hirta</i>	Euphorbiaceae	Young leaves
8	<i>Hygrophila salicifolia</i>	Acanthaceae	Leaves
9	<i>Oxalis corniculata</i>	Oxalidaceae	Leaves
10	<i>Polygonum</i> spp.	Polygonaceae	Shoot
11	<i>Phyllanthus acidus</i>	Euphorbiaceae	Leaves
12	<i>Allium tuberosum</i>	Liliaceae	Whole plant
13	<i>Amaranthus spinosus</i>	Amaranthaceae	Shoot
14	<i>Amaranthus viridis</i>	Amaranthaceae	Shoot
15	<i>Boerhavia diffusa</i>	Nyctaginaceae	Leaf and shoot
16	<i>Calamus erectus</i>	Poaceae	Shoot
17	<i>Centella asiatica</i>	Apiaceae	Whole plant
18	<i>Gnetum gnemone</i>	Gnetales	Leaf
19	<i>Ipomea aquatica</i>	Convolvulaceae	Leaf and shoot
20	<i>Oxalis corniculata</i>	Oxalidaceae	Whole plant
21	<i>Solanum media</i>	Solanaceae	Leaf and shoot
22	<i>Cassia floribunda</i>	Caesalpiniaceae	Tender shoots and pods
23	<i>Cassia tora</i>	Caesalpiniaceae	Tender leaves and pods
24	<i>Euphorbia royleana</i>	Euphorbiaceae	Pith of young shoots
25	<i>Polygonum orientale</i>	Polygonaceae	Leaves
26	<i>Bambusa tulda</i>	Poaceae	Young shoots
27	<i>Begonia palmata</i>	Begoniaceae	Young parts
28	<i>Ficus cunia</i>	Moraceae	Inner bark of stem
29	<i>Bauhinia vahlii</i>	Caesalpiniaceae	Tender pods and stem
30	<i>Bauhinia malabarica</i>	Caesalpiniaceae	Tender shoots and leaves
31	<i>Ficus virens</i>	Moraceae	Young shoots
32		Convolvulaceae	Whole plant
33	<i>Allium ampeloprasum</i>	Liliaceae	Young leafy shoots
34	<i>Alternanthera sessilis</i>	Amaranthaceae	Young leafy shoots
35	<i>Alternanthera philoxeroides</i>	Amaranthaceae	Whole plant
36	<i>Cassia sophera</i>	Caesalpiniaceae	Stalks
37	<i>Cassia occidentalis</i>	Caesalpiniaceae	Young leaves
38	<i>Cassia obtusifolia</i>	Caesalpiniaceae	Young leaves
39	<i>Amaranthus spinosus</i>	Amaranthaceae	Whole plant

Table 3 Names of some frequently collected edible floral part yielding wild plants of India

Sl number	Wild edible plants	Family	Parts used
1	<i>Bauhinia acuminata</i>	Caesalpinaceae	Flowers
2	<i>Ipomea alba</i>	Convolvulaceae	Calyx
3	<i>Rhododendron arboretum</i>	Ericaceae	Flowers
4	<i>Bauhinia purpurea</i>	Leguminosaceae	Petiole
5	<i>Artemisia capillaris</i>	Asteraceae	Flower
6	<i>Bauhinia variegata</i>	Caesalpinaceae	Inflorescence
7	<i>Cassia fistula</i>	Caesalpinaceae	Flowers
8	<i>Amomum dealbatum</i>	Zingiberaceae	Petiole
9	<i>Musa glauca</i>	Musaceae	Flower buds
10	<i>Madhuca longifolia</i>	Sapotaceae	Spike

Table 4 Names of some frequently collected edible root, rhizome, bulb, and tuber yielding wild plants of India

Sl number	Wild edible plants	Family	Parts used
1	<i>Allium bakeri</i>	Liliaceae	Bulb
2	<i>Allium chinensis</i>	Liliaceae	Bulb
3	<i>Allium platyspathum</i>	Liliaceae	Bulb
4	<i>Asparagus racemosus</i>	Liliaceae	Root
5	<i>Habenaria grandifloriformis</i>	Orchidaceae	Rhizome
6	<i>Bombax ceiba</i>	Bombacaceae	Tuberous root
7	<i>Boerhavia chinensis</i>	Nyctaginaceae	Root powder
8	<i>Curculigo orchoides</i>	Amariyllidaceae	Root
9	<i>Dioscorea oppositifolia</i>	Dioscoreaceae	Tuber
10	<i>Dioscorea tomentosa</i>	Dioscoreaceae	Tuber
11	<i>Dioscorea hamiltonii</i>	Dioscoreaceae	Rhizome
12	<i>Dioscorea bulbifera</i>	Dioscoreaceae	Tuber
13	<i>Dioscorea wallichii</i>	Dioscoreaceae	Rhizome
14	<i>Curcuma longa</i>	Zingiberaceae	Rhizome
15	<i>Purearia tuberosa</i>	Papilionaceae	Root

are some of the wild tubers used by tribals groups in India, e.g., Chenchus, Sugalis, and Yerukalsa of Andhra Pradesh. The roots of cattails (*Typha latifolia*), burdocks (*Arctium lappa*), and arrowheads (*Sagittaria sagittifolia*) are used frequently by people in Ireland. Cattails, thistle (*Cirsium* spp.) and *Bordiaea* are used by people of Pope Valley, California. *Ullucus tuberosus*, *Tropaeolum tuberosum*, and *Oxalis tuberosa* are common tubers collected in Peru, Ecuador, and Bolivia (Table 4).

Nuts, seeds, and grains Nut is the popular name for many kinds of dry, edible seeds or fruits that grow in a woody shell. The word nut can refer to both the shell and the nutmeat, or kernel, inside or to the kernel alone. Botanists define a nut as a dry, one-seed fruit surrounded by a hard shell that does not open on its own. Prehistoric people probably ate nuts as a regular part of their diet. Some nutritionists believe that, because of food shortages, nuts will again become a widely used source of protein. Seed is the specialized part of a plant that produces a new plant and has a supply of stored food. Seeds serve as a major source of food for millions of people throughout the world. Nuts

and seeds are good sources of fiber, protein, minerals such as iron, zinc, copper, magnesium, potassium, and calcium, vitamins such as vitamin E and phytosterols, and a variety of phytochemicals. Grains are the husked parts of inflorescences and are basically seeds of the Poaceae family. Wild grains, seeds, and kernels provide significant amounts of calories, protein, and oil. Their calorific value is frequently greater than that of the cultivated varieties. The results of analysis of the grass grains are impressive with a range of 310–391 kcals per 100 g which compares favorably with *Sorghum* sp. and maize (*Zea mays*) at 355 and 363 kcals per 100 g respectively. Names of some forest plants yielding edible kernels and seeds commonly collected in India are given in Table 5.

Forest edibles of animal origin Our ancestors were very much dependent upon wild animals for meeting their daily dietary requirements of protein, vitamins, and many minerals. These foods were not only capable of meeting their nutritional requirements but also gave them variety and taste. The various groups of animals found in the wild are not only eaten for their taste or nutritional value, but they have been

Table 5 Names of some frequently collected edible seeds and kernel yielding wild plants of India

Sl number	Wild edible plants	Family	Parts used
1	<i>Cycas circinalis</i>	Cycadales	Seeds
2	<i>Cycas pectinata</i>	Cycadales	Seeds
3	<i>Cycas revoluta</i>	Cycadales	Seeds
4	<i>Calamus erectus</i>	Arecaceae	Seeds
5	<i>Centella asiatica</i>	Apiaceae	Seeds
6	<i>Holoptelea integrifolia</i>	Ulmaceae	Seeds
7	<i>Solanum surattense</i>	Solanaceae	Seeds
8	<i>Bauhinia purpurea</i>	Caesalpinaceae	Seeds
9	<i>Bauhinia racemosa</i>	Caesalpinaceae	Seeds
10	<i>Bauhinia malabarica</i>	Caesalpinaceae	Seeds
11	<i>Bauhinia vahlii</i>	Caesalpinaceae	Seeds
12	<i>Cassia tora</i>	Caesalpinaceae	Seeds
13	<i>Cassia occidentalis</i>	Caesalpinaceae	Seeds
14	<i>Cassia obtusifolia</i>	Caesalpinaceae	Seeds
15	<i>Nymphaea stellata</i>	Nymphaeaceae	Seeds
16	<i>Vitex negundo</i>	Verbanaceae	Seeds
17	<i>Ocimum americanum</i>	Lamiaceae	Seeds
18	<i>Holoptelea integrifolia</i>	Ulmaceae	Seeds
19	<i>Prunus armeniaca</i>	Rosaceae	Kernel
20	<i>Juglans regia</i>	Rosaceae	Kernel
21	<i>Madhuca longifolia</i>	Sapoteaceae	Seeds
22	<i>Nymphaea nouchali</i>	Nymphaeaceae	Seeds
23	<i>Buchanania axillaris</i>	Anacardiaceae	Seeds

Table 6 Names of some frequently collected edible wild insects of few selected countries of the world

Sl number	Country in which used	Insects
1	Indonesia (Bali)	Compost beetle larvae, palm weevil larvae, dragonfly, damselfly adults
2	Nigeria	Westwood larva, palm weevil larvae, termites, crickets, grasshoppers, caterpillars, compost beetle larvae, wasp larvae
3	Japan	Aquatic insect larvae, cicadas
4	Australia	Witchety grub, honeypot ants, bogong moths, beetle grubs, <i>Oecophylla</i> ant
5	Algeria	Desert locusts
6	China	Cicada nymphs, Wasp larvae/pupae, Ants, Locusts, Dragonflies, Scorpions, Diving beetles, Giant water bugs
7	Philippines	June beetles, grasshoppers, ants, mole crickets, water beetles, katydids, locusts
8	Ecuador	Dragonfly larvae, Cyclocephala beetles, Cicadas
9	Mexico	Cerambycid larvae, lemon ants, ants
10	Papua New Guinea	Grasshoppers, <i>Atta cephalotes</i>
11	Thailand	Walking sticks, leaf insects, <i>Apies florum</i> , <i>Apies dorsata</i> , <i>Apies cerana</i> , <i>Apies mellifera</i>
12	USA	Termite (<i>Macrotermes subhyalinus</i>), caterpillar (<i>Usata terpsichore</i>), <i>Rhynchophorus palmarum</i>

found to be highly important medicinally too. Therefore, a wide range of insects, birds, and animals is collected from the forests along with the plants. The commonly collected mollusks in the UK are common mussel (*Mytilus edulis*), flat oyster (*Ostrea edulis*), common cockle (*Cerastoderma edule*), quahog (*Mercenaria mercenaria*), common razorshell (*Ensis ensis*), sand gaper (*Mya arenaria*). Hunting and gathering of animals from the forests is very common across the world, for example, in Kenya, Tanzania, Zimbabwe, Zambia, Malawi, Mozambique, and Botswana thousands of species of insects,

birds, mammals, reptiles, mollusks, and amphibians provide a cheap source of protein and livelihood to poor communities that are struggling to survive. Bushmeat (mostly the meat of wild mammals) is sold in departmental stores and served in hotels and restaurants of many African countries. Similarly the Naga and Khasi communities of India also hunt and gather a wide variety of animals for food which include bat, barking deer (*Muntiacus muntjak*), porcupine (*Hystrix hodgsoni*), wild boar (*Sus scrofa cristatus*), mithun (*Bos frontalis*), unio, and fowl, frogs, snakes, etc. (Table 6).

of wild-harvested ginseng from the USA was 191 500 kg worth more than US\$32.4 million. Retail sale of *Ginkgo biloba*, another plant of this category, totaled US\$90.2 million in 1997, while sales of *Hypericum perforatum* and *Podophyllum peltatum* plants growing in the forests of the USA yielding dietary supplements exceeded US\$47 million and US\$1.5 million respectively.

Edible Oils

Apart from the traditional uses of edible wild products there are some other ways in which the plants are used. In Brazil, people collect kernels from babassu plants (*Orbygnya phalerata*) which are a very rich source of edible oil, resembling coconut oil to some extent. Black walnuts are also a source of oil for the people of Brazil. In India kernels or seeds of *Prunus armeniaca*, *Juglans regia*, *Prinsepia utilis*, *Madhuca longifolia*, *Ventilago maderaspatana*, and *Fagopyrum esculentum* are used to extract edible oils and fats.

Social and Economic Issues

Wild edibles provide food security and livelihood to millions of rural poor people living around forests, and thus it plays an important role in the socio-economics of these communities. This is particularly important in Asia, tropical Africa, and South America. Forests also offer a great variety of food products of potential market value. The indigenous peoples of Amazon's State, Venezuela, have been selling their own native wild fruits. All indigenous peoples within Amazon's State have the right to hunt, fish, and collect wild products for their personal consumption; thus they have the right to continue their traditional lifestyles. Edible wild plant products are collected mainly for household consumption and for sale in the local market. Wild fruits and fish may be sold legally, but the sale of game animals, birds, and ornamental fish is strictly prohibited by law. The indigenous vendors and gatherers of forest edibles do not put up stalls, but instead sell along the pavement of weekly traditional markets. A similar situation is found in rural northeast India. In the Sudan, however, the perception of the economic importance of wild foods appears to be gender-specific. For women, these foods are an important source of income and with the small amounts of cash that they earn; they buy important non-food items such as soap. One reason that may lead outsiders to believe that there is not much trade in wild foods is that these foods are not usually sold in a prominent place in the market but on the periphery with a significant amount of barter trade being undertaken at village level. In Cameroon, hunting, trapping, and fishing

from the wild accounts for an average 27% of annual income, while income from other forest products totaled some 30% of yearly earnings. Earnings from bushmeat are quite high in Peru; a hare hunter can earn the equivalent of US\$1350 a month, compared with a laborer's typical wage of US\$100 a month. People of Papua New Guinea's swamplands have virtually no saleable resources apart from the crocodiles that abound in these densely vegetated areas. A single skin of a mature crocodile can fetch around US\$150. Other notable wildlife products obtained in various parts of the world and traded for high prices include snake venom and frogs' legs. The giant wild snail (*Achatina achatina*) is traded profitably in Côte d'Ivoire.

Cultural, Equity, and Gender Issues

In southern Sudan there is a social stigma attached with wild food items. Generally, male guests will be given sorghum because it is considered more prestigious while wild foods, and any other less prestigious foods are eaten by the women and the children of the household in a separate place. Allocating the best food to a guest is common to most cultures, but this does not mean that other household foods are nutritionally inferior or that they are not liked. There are some wild foods that have a high prestige value, such as the wild grass grains and rice which are particularly favored and will be given to the most important guests at ceremonies. Also, some wild foods are used to make relishes that give flavor and texture to other foods and are acceptable for male guests, e.g., fruits of *Tamarindus indica*, *Nauclea latifolia*, *Portulaca oleracea*, and *Gynandropis gynandra*. Female guests however tend to eat whatever the rest of the household eats. The collection of wild foods is mainly carried out by women and children. It does not necessarily involve expending a great deal of extra energy. Many foods are collected along the wayside whilst going about other chores, while wild leafy greens can be found growing (and are encouraged to grow) in the cultivated areas around the home. Collection of wild foods at a greater distance from the homestead will be undertaken by women who go in groups over a period of days, leaving their children in the care of a relative. These trips can become something of a social event for women, particularly for those who live on the more remote homesteads and have little time for visiting friends and relatives. Gathering some wild foods can be labor intensive, e.g., digging for wild tubers and for grain from termite stores, but people may choose to collect these foods even in normal years for the

Spices and Condiments

The term spices and condiments applies to 'such natural plant or vegetable products or mixtures thereof, in whole or ground form, as are used for imparting flavor, aroma and piquancy to and for seasoning of foods.' Spices may comprise different plant components or parts such as barks, berries, buds, bulbs, floral parts, fruits, kernels, leaves, rhizomes, latex, exudates, roots, and seeds. Spices are well-known appetizers and are considered essential in culinary art all over the world. They add tang and flavor to otherwise insipid foods. Some of them also possess antioxidant properties, while others are used as preservatives in some foods, e.g., pickles and chutneys. Some spices were used for preserving food like meat for a year or more without refrigeration as they contain chemical substances that inhibit the growth of microbes like bacteria. There are many spices and condiments that are collected from forests. Some wild plants used in India as spices are: *Acorus calamus*, *Thymus linearis*, *T. serpyllum*, *Eurya acuminata*, *Garcinia indica*, *Piper longum*, *Cinnamomum* sp., *Piper guineense*.

Beverages

Apart from the most popular beverages, viz. tea and coffee, there are many wild plants that are used as beverages by traditional societies. Leaves, twigs, or fruits of several wild plants are used for preparing beverages. For instance spearmint (*Mentha spicata*), saffras, mitten tree, ague tree, or tea tree (*Sassafras albidum*), yarrow (*Achillea millefolium*), sweet fern, Labrador tea (*Ledum groenlandicum*), sagebrush (*Artemisia* spp.), and Mormon tea (*Ephedra* spp.) are widely used in eastern and western USA as beverages. Others include Coyote mint (*Monardella odoratissima*) and clover (*Trifolium* spp.).

Rubus allegheniensis, *Fragaria virginiana*, *Vitis* sp., etc. are used to prepare both tea as well as cold drinks, in Mound City, Ohio. The Saskatoon (*Amelanchier alnifolia*) and pin cherry (*Prunus pennsylvanica*) is used by indigenous peoples of North America as soups and tea. Berries of sumac (*Rhus* spp.) are also used as tea. *Cassia occidentalis* and *C. tora* seeds are used as substitute for coffee in Africa and America. In India, *Albizia julibrissia*, *Coffea khasiana*, *Camelia kissi*, *Eschscholtzia cristata*, *E. polystachya*, *Taxus baccata* (bark and leaves), and *Cassia auriculata* are used as substitutes for tea and coffee, while berries like *Rubus* spp., *Fragaria* spp., and *Hemidesmus indicus* are used in preparation of cold drinks. *Madhuca indica*, *M. longifolia*, and some members of palm family are used in preparation of alcoholic beverages in India. The

floral parts and leaves of *Cannabis sativa* is used for preparation of intoxicating drinks and stimulants.

Mushrooms

Mushrooms are yet another very frequently and commonly used products of forests. While most species of mushrooms are almost freely available to forest-dwellers and help them survive or supplement their diets, there are some wild mushrooms, viz., *Morchella esculenta*, which are amongst the most expensive edibles on earth. Indigenous collectors of the northwestern Himalayas sell these to middlemen at rates as high as US\$100 kg⁻¹, and they pass it on to quality hotels and pharmaceuticals companies earning a profit of 35–40%.

Apart from adding variety to our diets mushrooms are also an important source of proteins and minerals. Hundreds of types of mushrooms are collected from the wild. While most of them are collected by the forest and forest fringe dwellers for their subsistence and as a food supplement, a small quantity is traded in local as well as regional and international markets.

Medicinal Plants

Since the beginning of civilization, people have used plants as medicine. It came into being when the earliest humans observed the animals mostly the apes and monkeys eating certain plants often to satisfy their hunger and at other times to heal their wounds and to alleviate suffering. This observation and the analysis of such observations probably led them to use plants for maintenance of life and alleviation of diseases. The earliest recorded uses have been described in the Vedic literature, roughly around 4500 BC. This traditional curing system is still being followed in India. In the recent years this practice has been rejuvenated and is being widely used over the other systems. A detailed account of medicinal plants can be found elsewhere in this Encyclopedia (see Medicinal, Food and Aromatic Plants: Medicinal Plants and Human Health; Tribal Medicine and Medicinal Plants).

Health Foods and Dietary Supplements

A large number of forest products of both plants and animal origin are believed to be beneficial in maintaining good health, as aphrodisiacs, and in increasing resistance to stress. They are probably the highest valued edible forest products on the market today. For example a digger of wild ginseng (*Panax quinquefolium*) in the USA can receive more than US\$1000 kg⁻¹ of dried root. There is a huge market for ginseng in Asia particularly in Taiwan and China. In 1997, the total export

sake of dietary variety. Wild plant production only involves labor at the time of harvesting and may fit in well with other activities. In the case of grass grains, for instance, which start to ripen at a time when agricultural work is at a minimum, prior to the main crop harvest, there is little conflict of labor priorities. The collection of wild food may become burdensome when these foods become the major part of the diet, e.g., during periods of food scarcity and famine, especially when the foods need to be foraged for at great distances from the home. Whilst out on their errands children often forage for these foods. During this time they learn about the different wild foods and their availability which can stand them in good stead during periods of food deficit. Also, as growing children need food regularly throughout the day, wild foods can provide snacks between their main meals.

In Ethiopia also wild foods are often considered to be of low status, and their consumption is regarded as a source of shame. In normal times only children, youngsters, and the poorest families regularly collect and consume wild food. In Kayissa Kebele, wild food plant species are not consumed by the majority of the population except when there is a serious shortage of food affecting all strata of the population from the poorest to the richest. But for the poorest, collection and consumption of wild food may make up an important portion of their daily activity and dietary intake. Ethiopians generally are constrained to the consumption of the commonly cultivated crops and neglect wild plants like *Amaranthus* and *Solanum khasianum*. Strong traditions, beliefs, and religious taboos still obstruct people's willingness to domesticate and cultivate wild-food plants. In the southern part of Ethiopia, where there are many different tribes still living with their indigenous beliefs and traditions, there are fewer religious and external constraints than in other parts of the country. In these areas the daily diet of most people still comprises an element of wild food, both animals and plants, during certain periods of the year. Here mostly children collect and consume the fruits of wild plants. Other wild food and 'famine food' plants are collected by children and women and prepared by the latter. Women frequently collect wild food when they are on their way to fetch water, to collect firewood, or to the market, and when walking home from their fields.

Conservation Needs

As the area of the earth's surface under forest is shrinking at an alarming rate, so also is the

availability of edible forest products. The natural forests of the tropics are the most important source of such products, both in terms of quantity and also in numbers of different edible species. Ironically these are the forests that are also facing the maximum anthropogenic pressures. Millions of rural poor look on the edible forest products as a source of food, researchers and scientists look on them as a possible source of germplasm for breeding, and the urbanites and rich often use them as a recreational food. Probably, it is not an exaggeration to say that modern humans are as dependent on the forest for food and healthcare as were the primitive humans. Also, the quantity and variety of edibles extracted from forests today far exceeds those extracted during remote past when all people lived in forests. For instance, in the past the collection of bushmeat from the African savanna would have been ecologically sustainable, but now it has far exceeded the carrying capacity of these ecosystems. Studies have revealed that at present trade in bushmeat is one of the main causes of falling animal populations in much of Africa, but bushmeat cannot be done away with as it provides a much-needed source of protein to the rural poor who cannot afford to buy farm-produced meat. However, conservation interests and food security interests must work together to balance food needs with long-term wildlife management.

Any strategy for sustainable management of EFPs will have to take a multilevel approach. It must cover documentation and identification of lesser-known EFPs, research on regeneration so as to decide about levels of extraction, improvement of methods of collection and harvest, ways to minimize loss during harvest, storage, and processing, research on substitution of products that come from endangered species, domestication and cultivation of EFP species, market research, resource accounting, education and awareness about conservation and management of EFPs and *in vitro* and *in vivo* conservation using modern biotechnological tools. Involvement of various stakeholders in formulating policies and enacting legislations favorable for EFPs conservation may also be desirable for evolving effective conservation strategies.

Conclusion

Forests are the source of huge quantity and enormous variety of edible products which are used by almost all sections of society through out the world. They provide subsistence to millions of rural poor and forest-dwellers as well as nutritious delicacies to the urban rich. They are a repository of germplasm of many food crops and farm products and a large

number of them have potential for domestication and cultivation on commercial basis. Edible NWFPS received notable attention at the United Nations Conference on Environment and Development (UNCED) in Rio in 1992 and thereafter forest managers of several countries have recognized the importance to forest edibles in management of forests. However, there is conspicuous lack of understanding among resource managers and planners on sustainable harvest, value addition, equitable sharing of benefits, marketing, and conservation of these resources.

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MENSURATION

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Introduction

The field of forest measurements is concerned with measurement, sampling, analyses, and prediction of properties and characteristics of the forest, including trees as well as other components of the forest ecosystem. In general, the main objective of forest measurement activities is to provide quantitative and qualitative data for forest management, policy-making or research. Forest measurements thus contribute substantially to the basis of forest-related human activities. Often, data acquisition is carried

out as part of a forest inventory, at estate, regional, or national level, or in scientific field experiments. Several forest measurement procedures can be used outside of the forest, for example in inventories of trees in urban streets and parks or in the landscape.

Forest Measurements

Historically, science-based forest measurement procedures were developed mainly for aboveground parts of the trees and with the main objective of quantifying the wood resource and its growth potential. Including the planning, performance, and analyses of measurements of tree and stand attributes, this is usually referred to as the discipline of dendrometry (i.e., tree measurement), forest mensuration, or forest biometrics.

In the classical sense, measurements tend to be at the macroscopic level and are often carried out in the