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Native Fruit Crops of Vietnam and Their Close Relatives

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Abstract

Native fruits abound in Vietnam and many of them offer opportunities for agricultural development. There are over 130 species of fruit crops cultivated in Vietnam, representing 39 families. In a previous paper, we described the most important introduced fruit crops in Vietnam. Herein, we discuss the different native fruits, both wild and cultivated.

Introduction

In recent years, tourists have begun to flock to Vietnam. One of their first sights is the myriad of fresh vegetables, fruits and spices that are on display in the open markets. The Vietnamese are very fond of eating at foodstands that are mushrooming along city streets. A glance at these stands reveals the importance of fresh vegetables, aromatic leaves, spices and fruits in Vietnamese dishes. In addition, most Vietnamese eat fruit for dessert instead of cake as in the West. The Vietnamese passion for food is expressed in numerous children's rhymes, folk songs and novels.

Fruit production in Vietnam is an area where tremendous economic gains could be made. This potential can be extrapolated from the experience of Malaysia, where with only half the acreage of Vietnam, Malaysian fruit export revenue is comparable to that of Vietnam (10). Fruit crops with potential for export include many native fruit species of world importance [such as banana, citrus longan, mango, persimmon and litchi (7, 19)] and many introduced crops [such as guava, papaya, caimito, sour- and sweetsops (8, 19)]. There are more than 130 fruit crops belonging to 39 families (21, 23), cultivated in Vietnam.

We present here an overview of the native species that might have commercial potential and to describe the rich genetic storehouse that exists for crop improvement in Vietnam. These crops are grouped according to their required climatic growing conditions: 1) tropical, 2) sub-tropical, and 3) temperate. Temperate fruits grow successfully in Northern Vietnam and the West Plateau, while tropical fruits can be cultivated in southern Vietnam (23). The native relatives of several economically important fruit crops that were introduced to Vietnam are not described here, as they have been discussed elsewhere (7).

Tropical Fruits

Nephelium lappaccum L. (Rambutan) is a native of Malaysia, Indonesia and Vietnam. It belongs to the *Sapindaceae*, a family that includes the fruit crops longan and litchi, and a number of species used as cleaning agents. Vietnam is in the distribution range of var. *pallens*, which are tall trees (12-15 m) with strikingly colourful clusters of fruits. The fruits are 4-6 cm wide, soft with a hairy pericarp, and are coloured red, yellow or orange (depending upon genotype). The pulp of the fruit generally sticks tightly to the seed, but there are genotypes whose pulp is easily removed (18). Roasted seeds of

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rambutan are said to have anthelmintic properties (13).

Other edible *Nephelium* described wild in Vietnam include: 1) *N. ramboutan-ake* (Labill.) Leenh (*N. mutabile* Bl.), pulasan, which grows at high elevation. Its fruits have spinterns that are short and stumpy, unlike those of rambutan which are long and filiform. Furthermore, all genotypes have a yellow pulp that peels easily from seeds, 2) *N. philippense* (*N. intermedium* Radlk.), bulala, 'which has even shorter spinterns than rambutan, and 3) *N. cuspidatum* Bl. which has fruits closely resembling those of rambutan. However, it has a longer trunk and larger, more drooping leaflets that are hairy on their upper surface (18). *N. philippense* is probably a synonym to *N. ramboutan-ake* (Francis Zee, personal comm.).

The taxonomy of *Nephelium* is not clearly resolved. Pham-hoang (12) specified that the Vietnamese *N. cuspidatum* described by Tindall et al. (18) belongs to var. *bassacensis* (Pierre) Leenh. In addition, he described two more native taxa of *Nephelium*, found in unspecified locations in Vietnam, including 1) *N. hypoleucum* Kurz. (*Xerospermum cochinchinensis* Pierre), with red fruit color, and 2) *N. melliferum* Gagn. Boc which has fragant, white, pubescent flowers, and fruit (4 cm wide) with spinterns that are about 7-9 mm long.

In countries neighbouring Vietnam, rambutan has become an important export commodity, with Thailand and Malaysia being leading producers. Vietnam could also become a major producer of rambutan. Although Vietnamese genetic stocks of rambutan are important for cultivar improvement, many cultivated and wild rambutans have been threatened or already lost in Vietnam (19), partly due to the increasing use of clonally propagated stock (18).

Dimocarpus longan Lour. (Longan), is found both cultivated and wild, growing along the seashore in Vietnam. Three taxa of *Dimocarpus* have been described: 1) subsp. *longan* var. *longepetiolulatus* Leenh., with pubescent, short inflorescences and 2 cm wide fruits, 2) subsp. *longan* var. *obtusus* (Pierre) Leenh. with paired fruit on top branches and leaf axils, and 3) subsp. *malesianus* Leenh. which has pubescent young branches that make it appear powdery. This variant has small, 1 cm wide fruits, which are white, yellow or red with black seeds (12).

In a recent survey conducted by the Long Dinh Fruit Crop Research Center, twenty-five landraces of longan were identified in south Vietnam. 'Nhan Long Trai To' is particularly popular because of its large fruits, and 'Nhan Tieu Da Bo' is getting increased attention because it has superior yields and two harvests per year (14). In northern Vietnam, 'Nhan Hung Yen' is famous for its great taste.

Syzygium spp., (Water apple) of the *Myrtaceae,* is an important fruit genus in Vietnam. At least two cultivated species are native: 1) *S. semarangense* (Bl.) Merr. & Perry which has particularly elegant flowers, composed of 4 white petals, numerous white stamens, long green stigmata and inferior ovaries. It produces white or pink berries that have 1-4 brown seeds, and 2) *S. jambos* (L.) Alston which has fragant yellow, sweet berries that have a crisp flesh and gray seeds.

Four wild species of *Syzygium* are occasionally gathered for their edible berries: 1) *S. bullockii* (Hance) Merr. & Perry, a short (1 m) tree that has flowers in corymbs and oval berries, 2) *S. chanlos* (Gagn.) Merr. & Perry, a short tree that has small (1.5-2 cm wide), white berries that are sweet with a single seed, 3) *S. formosum* (Wall.) Massam, a tall tree with large (4 - 4.5 cm wide) berries that have a bland taste, and 4) *S. jambos* var. *silvaticum* (Gagn.) Merr. & Perry, with 3 to 4 seeded fruits and inflorescences that are on the top of very short branches.

At least 5 wild relatives of water apple are used for purposes in addition to nourishment (11): 1) *S. polyanthum* (Wight) Walp. (San), has leaves with antibiotic

properties and one-seeded, black berries that are 6-9 mm wide. Its bark is also used to make strings for fishing rods, 2) *S. tinctorium* (Gagn.) Merr. & Perry, has bark which is processed for yellow and brown colored dyes. Its oval berries are 2 - 3 cm long, 3) *S. cumini* (L.) Druce, (Java Plum) which has 13 - 20 mm, globulose and purple black berries with a single seed that are used to treat diabetics, 4) *Cleistocalyx nervosum* D. C., has bright red, globulous or oblong berries that are 7-14 mm wide, with sweet flesh and one seed. It is used to make beverages to treat indigestion and intestinal diseases, and 5) *S. zeylanicum* (L.) D. C. has white, berries (7 cm wide) with a single seed. Its bark is used for dyes of unspecified color (11).

Several other famous native species of *Myrtaceae* found in Vietnam are: 1) *Rhodomyrtus tomentosa* (Ait.) Hassk., Rose Myrtle, a short (1.5 m) shrub or tree that has edible purple berries which can be made into wine. Most urban Vietnamese know by heart the poems and songs written by soldiers about the romantic rolling hills of violet flowered Sim trees, 2) *Melaleuca leucadendron* (L.) f., "Tram." The extensive forests burned down by napalm bombs during the Vietnam war have been restored and are now a haven for wildlife again, particularly in the Tram Chim reserve in the Mekong delta, and 3) *Baeckea frutescens* L. ("Choi Se"), an oil producer used by Vietnamese to treat colds and fever.

Several native species of *Artocarpus (Moraceae)* are cultivated: 1) the Jackfruit, *A. heterophyllus* Lamk. (*A. interrifolia* Forst.), a tall tree up to 20 m tall with golden yellow wood. While the literature indicates that the jackfruit originated in India and Malaysia, it is reported as growing naturally in the forests of Bo Trach, Quang Binh (22) and is grown in South Florida (1). Its large fruits weight 3-15 kg, sometimes 30 kg, are full of spines and grow on tree trunks and main branches. Young fruits are used to make pickles and ripe fruits are eaten fresh. Seeds are boiled or roasted, and eaten like nuts. In collective farms, cultivated jackfruits can yield 24 tons/ha/year (22). They have become an important component of Agro-forestry and animal feed. Its wood is used for making coffins, building construction and art work. Ton-that (18) suggested that the jackfruits taste is not to the liking of Westerners. However, it has great potential for export as fresh jackfruits command very high price in Asian stores in North America. In addition, jackfruit chips are very tasty, 2) *A. interger* (Thunb.) Merr., a tall tree with fragant, sweet fruit whose pulp is easily removed from the pericarp. Its fruits are smaller than that of *A. heterophyllus,* only 20-30 cm in length. Its leaves are used to increase the milk production of lactating women and its wood is thought to have medicinal properties as sedatives and to lower blood pressure, and 3) *A. nitida* Trec. subsp. *lignanensis* (Merr.) Jarr. (*A. sampor* Gagn.), with 6-7 cm wide fruits, without spines, that are on 4-5 cm long pedicels. The syncarp has pinkish flesh with very large seeds (15 x 12 mm). Its use, was previously limited to its bark, for chewing with betel nuts and leaves; however, it is now grown widely in gardens for its succulent berries, shade and to stabilize soils. Its soft wood is used to make household utensils (22). This species is also growing in the wild in Phu Khanh and Bien Hoa.

There are 10 other species of *Artocarpus* found in Vietnamese forests (13). In northern Vietnam, 3 species are located: 1) *A. tonkinensis* Chev. ex Gagn., with smooth, shiny fruit, 2) *A. petelotii* Gagn. with pubescent, velvety fruits, and 3) *A. lakoocha* Roxb., with duck's egg-sized fruits that are yellow and bulging where the seeds are located. In central Vietnam, 3 native species are found: 1) *A. borneensis* Merr. subsp. *griffithii* (Kurz.) Jarr., with small, 2 cm wide, shiny fruits which are sour and have few seeds, 2) *A. lowii* King, with spiny syncarps that are about 6-8 cm wide, and 3) *A. melinoxyla* Gagn.,

with globulous fruits (7 cm wide) that are on 7 cm long pedicels. In south Vietnam, there are 3 species: 1) *A. rigida* Bl. subsp. *rigida* and *A. rigida* subsp. *asperulus* (Gagn.) Jarr. with globulous, spiny fruits (7-8 cm wide) that contain small seeds (1.2 cm long), 2) *A. chaplasha* Roxb., with globulous fruits that have sharp, short spines, and seeds about 2 cm long, and 3) *A. gomezianus* Wall., with small, velvety fruits (2.5 x 3-4 cm) that are covered with mosaic spots. They have red flesh and large 8 x 5 mm seeds. Another wild species, *A. styracifolius* Pierre, has its distributional range in north and central Vietnam on hilly and mountainous landscapes. It is a short tree (6-7 m tall) with rambutan-like fruits.

There are 3 species of *Phyllanthus (Euphorbiaceae)* utilized by Vietnamese (11). These are: 1) The widely cultivated *P. acidus* (L.), with sour, yellow drupes that have 3 round grooves and a hard pith, and high levels of vitamin C. It is eaten fresh or pickled, and is available in Asian stores across North America, 2) *P. emblica* L., with small drupes (1-1.25 cm wide) that are also high in vitamin C, and 3) *P. reticulata* Poir., with leaves that are used for black dyes and antibiotics to treat skin diseases.

There are two edible species of *Baccaurea (Euphorbiaceae)* native to Vietnamese forests that are sometimes cultivated: 1) *B. silvestris* Lour., a medium sized tree (6-7 m) that is monoecious. Its inflorescences are 20 cm long and produce round, 2.5 - 3 cm wide red berries with 2-4 seeds, and 2) *B. ramiflora* Lour. (*B. sapida* Muell. Arg.), rambai, which is a tall tree (10-15 m) with round, yellow fruit that are 3 cm wide. The fruit have a thick, crisp pericarp which encloses wedges of delicious white flesh in compartments with or without seeds. The fruit taste varies widely from sweet to sour. There are also numerous other native species of *Euphorbiaceae* which are used by local people for properties other than fruit such as medicines, fish poisons, paint oils, edible oils, dyes, tea, speciality woods, edible leaves and ornamentals (11). Many of these are used for more than one purpose.

There are at least 5 native relatives of the Hog plum, *Evia dulcis* (Park.) Kost., *Anacardiaceae,* that are harvested for their edible fruits in Vietnam (5, 12): 1) *Allospondias lakonsensis* (Pierre) Stapf. which also provides good timber; 2) *Choerospondias axillaris* (Roxb.) Burtt & Hill. (*S. axillaris* Roxb.), 3) *Spondias pinnata* (Koenig & L. f.) Kurz., 4) *Dracontomelum duperreanum* Pierre, and 5) *D. dao* (Bl.) Merr. (16). Both *A. lakonsensis* and *C. axillaris* are cultivated in home gardens in northern Vietnam (4). The widely cultivated Golden apple, previously described as *Spondias cythera* (12), was originally domesticated on the Society Islands and introduced to tropical countries in Asia Pacific. Its popular fruits, the size of a duck's egg are sour and crispy. Its single hard stone has long, stiff and curly spines penetrating the mesocarp.

Four native species of *Apocynaceae* have edible fruits: 1) *Willughbeia edulis* Roxb., a climbing vine which grows wild in the forests but is also cultivated for its egg-sized, yellow fruits with white flesh and many seeds. It is commonly sold in markets (22), 2) *W. cochinchinensis* Pierre, a small tree, which has large, 4-5 cm globulous, yellow skinned fruit with stripes. They have a sweet and sour flesh with flat, round seeds, 3) *Melodinus annamensis* Pit., a climbing vine which has 4-8 cm long terminal cymes, bearing many fragant white flowers which are yellow at the center. Its fruit are 7.5 cm long with many seeds and 4) *M. tournieri* Pierre ex. Spire, a climbing vine whose terminal cymes have ivory-coloured flowers. Its fruit are 6-7 cm wide with a hard pericarp (3-4 mm thick) and flat seeds.

Numerous members of the *Meliaceae* found wild in forests have edible fruits, and many of them are used as herbal medicines, vegetables, and/or construction

materials. Some of the most important species are: 1) *Aglaia dupereana* Pierre, cultivated coutrywide for its fragant flowers that are used to add aroma to tea, 2) *A. odorata* Lour., cultivated countrywide for its lovely fragant yellow flowers, 3) *A. cambodiana* (Pierre) Pierre & Pell., a small to large tree which has 3 chambered berries that are 2.5 cm wide with edible arils, 4) *A . euphoroides* Pierre, a 20 m tall tree, with small perfect flowers and reddish berries with edible seeds, 5) *Sandoricum koetjape* (Burm.f.) Merr. (S .indicum Cav.), a very tall tree (20 - 30m tall) which has 8 x 6 cm drupes with velvety yellow skin and sour, finely-fibered, white flesh. 6) *Walsura bonii* Pell., a large tree with fleshy berries, and 7) *W. cochinchinensis* Harms., which has edible yellow berries with opaque arils (12). Tankard (16) reported that *Aglaia* spp. and *Walsura* spp. have fruits resembling that of the introduced *Lansium domesticum* Hiern. var. *lansat* Jack. of *Meliaceae*.

Gnetum is an important genus in the *Gnetaceae,* which includes species used for fruit, vegetables, edible seeds, fiber and beverages. The majority are dioecious. The *Gnetum* most popular for their fruits are: 1) *G. montanum* Margf., a dioecious vine which flowers from June-October. Its egg-shaped fruits, yellow when ripe, are available from November to March, 2) *G. latifolium* Bl., and 3) *G. gnetum* L. var. *griffithii* Margf. Ripe fruit of the latter two species are peeled, boiled, and dried for later use. For consumption, the dried fruits are soaked in water and roasted. Their sweet tasting leaves are also used in soup (22).

Flacourtia is an important fruit genus in the family *Flacourtiaceae*. The most important cultivated native species is *F. rukkam* Zoll & More, a 15 m tall tree which has hermaphrodite flowers. Its 2.5 cm wide fruits have a pungent taste that is removed by massaging the fruit (11). The introduced species, *F. jangomas* (Lour.) Raeusch, Indian Plum, is widely cultivated from Hue to Ho Chi Minh City up to 600 m elevation. This large, deciduous tree has dark red berries, 1.5 - 2 cm in diameter, with a small and flat pith. It is an Indian native and not found in the wild. There are 2 wild species of *Flacourtiaceae* distributed in the forests of Central Vietnam: 1) *F. montana* Grah., an 8 m tall, monoecious tree that has red wood and fruits with a hard 1 cm wide pith, and 2) *F. indica* (Burm. f.) Merr., a tree with prickly thorns, and red, oval fruit that are fleshy with a hard pith (11).

Three native species in the *Celastraceae* family are widely utilized in Vietnam including: 1) *Salacia typhina* Pierre, a climbing vine which has edible fruits and high quality bark fibers, 2) *Siphonodon celastrineus* Griff., a 12 m tall tree with round to ovoid drupes that are 3 - 4 cm long, and 3) *Celatrus paniculatus* Willd., a small crawling tree whose seeds are believed to improve male virility (12).

Fruit of *Azima sarmentosa* (Bl.) Benth. & Hook. (*Salvadoraceae*) are also collected from the wild. It is a sharp thorned shrub found in mangrove forests and has white edible fruits which are 6 mm wide (12).

Sub-tropical Fruits

Lichi chinensis Sonn. (Litchi), the most famous fruit of the Sapindaceae, is cultivated in North Vietnam where the climate has a high number of chilling hours and a long dry season (19). Litchis are not found in the wild state (15). The most popular cultivars, currently grown worldwide, have their origin in Canton, China. However, many workers believe that the crop was originally introduced to China from Malaysia. Considering that litchi were brought to the Chinese court from Vietnam (16), there is a possibility that it may have been domesticated in Vietnam.

The villages of Thanh Ha and Phu Ho, near Hanoi, are well-known for their litchis and some plants are 200 years old (20). The famous landrace 'Vai Thieu' from the Thanh Ha village is now cultivated widely across the country (24). The

evergreen litchis, generally 10-12 m tall (although some plants can reach 20 m after 25-30 years of cultivation) are very attractive in all seasons, particularly at harvest time when bunches of red fruits hang like ornaments. At the Phu Ho Fruit Crop Research Center (PHFCRC), there are 25 accessions of litchi being maintained (6).

Pham-hoang (1991) described 69 native species of *Diospyros* (Persimmon; *Ebenaceae*) in Vietnam. All are native, except for the important crop species *D. philippensis* (Desr.) Gurke, which was introduced from the Philippines. Most of the species produce edible fruits and many are also prized for their wood. The most well-known timber species is the "Go Mun" (*D. mun*) with its shiny black wood used by artisans. Four species are widely cultivated: 1) *D. decandra* Lour., a large tree that has clusters of yellow female flowers that give rise to very fragrant, globulous, flat fruits. The fruit are thought to have nematicidal effects (2) and sedative properties (11), 2) *D. lotus* L., a small tree that has solitary, axillary female flowers which turn into purple-black berries when ripe. The fruit are often dried and are considered medicinal, 3) *D. roxburghii* Carr., a 15 m tall tree with globulous, pubescent berries that are 2.5 cm long, and 4) The most important cultivated species, *D. kaki* L., which has solitary female flowers and clusters of yellow male flowers. It produces smooth, orange or red berries, containing brown, hard seeds that are round to rectangular. There are many cultivars of *D. kaki* grown in Vietnam including 'Hong The,' 'Hong Vuong,' 'Hong Noi,' 'Hong Lang,' 'Hong Day,' 'Hong Thach That' and 'Hong Hac Tri' (11).

Six forest species of *Diospyros* are commonly utilized in Central Vietnam: 1) *D. nhatrangensis* Lec., a 3-10 m tall tree that has flat, round fruits which are 2.8 x 1.8 cm in size with black seeds. The tree has attractive red-colored timber, 2) *D. rhodocalyx* Kurz., an 8-m-tall tree with brown pubescent berries, 1 cm wide, developing from female flowers which are solitary at leaf axils. It has hard wood, 3) *D. bangoiensis* Lec., a 10 m tall, buttressed tree which has fruits 2.5 x 3.5 cm wide that are yellow, flat with brown pubescence on 1-1.3 cm long pedicels. The species has hard wood that is used by artisans, 4) *D. lobata* Lour., a small tree which has fragant white flowers arranged on cymes and timber that is among the best, 5) *D. pyrrhocarpa* Miq., a large 30 m tall tree that has fruits which are globulous and 4-5 cm wide, and 6) *D. ferrea* (Willd.) Bakh., a 10 m tall tree that produces 1 cm long elliptic fruits.

The PHFCRC has collected more than 20 selections of persimmon in Vietnam. Some cultivars maintain their taste much better than others after being dried, while others are superior root stocks. There is also tremendous diversity in earliness of fruit ripening (6).

Ziziphus (Jujube) is the most important genus of *Rhamnaceae,* which contains many medical and fruit species (9). Two introduced species are cultivated in Vietnam: 1) *Z. mauritiana* Lamk. (*Z. rotundifolia* Lamk; Indian jujube), a small tree that has axilliary cymes with small yellow flowers and fruits 2-3 wide with yellow, sour flesh and a hard stone, and 2) *Z. jujuba* Miller (Chinese jujube) (2), with characteristics similar to the Indian jujube, except that its fruit shape is elongated instead of being round. Improved jujube has been introduced from Thailand. This fruit is being cultivated on 400 ha in northern (Phan-Quynh Son, pers. comm.) and 600 ha in southern Vietnam (10). Seven cultivars are being used with Dao Muon and Dao Tien as the most tasty (Phan-Quynh Son, pers. comm.).

There are 4 well-characterized wild species of *Ziziphus* in Vietnam. These are: 1) *Z. rugosus* Lamk., a small tree (1-8 m) with long, inflorescences (25 cm), apetalous flowers and round, 1 cm wide drupes, 2) *Z. oenoplia* (L.) Mill., a small tree with black drupes, 7-10 mm wide

that have stones and contain 1-2 seeds, 3) *Z. poilanei* Muell., a small plant with yellow drupes, up to 12 mm wide, with hard stones, and 4) *Z. incurva* Roxb., a small tree that produces small fruit with 2 seeds. Other native wild species are: 1) *Z. laui* Merr., 2) *Z. funiculosa* Ham. ex. Laws., 3) *Z. hoaensis* Pierre, and 4) *Z. cambodiana* Pierre.

An edible species of *Rhamnaceae* found in Vietnam is *Sageretia theezans* (L.) Brogn (Hedge Sageretia). This small tree has erect spikes with 1-4 small flowers and gray, tomentose calyxes. Its black drupes, with 1-3 seeds, are sour. Its leaves are used for tea.

Canarium or "Tram" (*Burseraceae*) is an extremely important native genus in Vietnam. Tram has been associated with Vietnamese culture since its foundation. Vietnamese have traditionally consumed Tram fruits together with the kutzu tuber, *Pueria lobata* (Willd.) Ohwi var. *thompsonii* ("Cu San"). In some historical shrines such as Co Loa, Dien Chau, Trieu Son and Phong Chau, these traditions live on (22).

Pham-hoang (12) described 7 species of *Canarium* in Vietnam with edible fruits: 1) *C. tramdenum* Dai & Yakol. (*C. nigrum* Lour.) with yellow flowers and fruits which turn black when ripe. Its seeds are extracted for oil and it has soft fragant wood that is used to make incense, 2) *C. album* (Lour.) Raeusch. ex DC., a large tree which produces a white latex that is used in the paint and printing industries, 3) *C. parvum* Leenh., with fruits that have a triangular pith and non-pubescent young branches and unisexual flowers, 4) *C. bangalese* Roxb., also with fruits that have a hard triangular pith, 5) *C. subulatum* Guill. with flowers that are located at leaf axils or branch tops, 6) *C. lyi* Dai & Yakol., and 7) *C. littorale* Bl. (Benn.) Leenh.

There are at least 6 edible species of *Ficus* (*Moraceae*) native to Vietnam (13): 1) *Ficus auriculata* Lour. (*F. roxburghii* Wall. ex. Miq.), a medium sized tree with large, red fruits that are round (4 cm wide) with yellow pubescence. Ripe fruits are sweet and contain many seeds within a glutinous, transparent film. Young fruits are used as vegetables (22), 2) *Ficus glomerata* var. *chittagonga* (Miq.) King, a large tree that has edible young leaves and pear shaped fruits that are produced on tree trunks and branches. Its fruits are reddish-brown when ripe and are used as fish feed. Its leaves are used to wrap meat loaf (22), 3) *F. fulva* Reinw. ex. Bl., with round syconia, in groups of 1 to 3, that are large (1.5-2 cm wide), and covered with yellow hairs, 4) *F. stenophylla* Helmsl. var *stenophylla,* with edible, black syconia that are elliptical and 7 x 5 cm in size, 5) *F. benjamina* var. *nuda* (Miq.) Barret, with round syconia, 1.8 cm wide, that are green and very tasty, and 6) *F. altissima* Bl., with yellow and sessile syconia that have thick, sour flesh. It is also a popular shade tree. The Mediterranean native, *F. caria* L., is cultivated in Nha Trang (13).

Livistonia saribus (Lour.) Merr. ex. Chev. of *Palmaceae* is found in native secondary forests and is widely cultivated, particularly in the midlands. Its ovoid fruits are edible, but it is grown primarily for its leaves which are used for roofing and making hats, raincoats and baskets. Its stems are also used to make water pipes and fences.

Temperate Fruits

Several species of *Carya* (*Juglandaceae*) are native to Vietnam. The most important species is *C. sinensis* Dode (*Annamocarya sinensis*), a tree about 30 m tall and 70-80 cm wide at chest height, with a prominently buttressed trunk. It has unisexual flowers on individual spikes and large fruit (6-8 x 5 cm), with pointed tips. There have been some efforts to cultivate this species, although they are utilized mostly in the native state (22). Other important *Carya* in Vietnam are: 1) *C. poilanei* (A. Chev.) Leroy, with round fruit (2 - 2.4 cm wide) and one large seed, and 2) *C. tonkinensis* Lec., a tree about 15

m tall with unisexual flowers and fruit about 2.5 cm wide. These fruit are easily broken into 4 pieces, while their oily endocarp break into only 2 parts. In 1990, an expedition sponsored by the United States Department of Agriculture collected germplasm of *Carya* from Asia, including Vietnam. Collections were made of *C. sinensis* Dode and *C. tonkinensis* Lec. in the Cuc Phuong National Park and the Northwest Forest Research Center in Son La, respectively. They are also being conserved *in situ* in these locations (3).

Three genera of *Fagaceae* produce edible fruits in Vietnam (13). The most important cultivated species is *Castanea mollissima* Bl., a monoecious tree with good timber. Its tasty nuts, enclosed in prickly spines, are starchy and have a taste similar to that of jackfruit seeds. Its leaves are used as animal feed. The crop is grown in a mixture with other trees in the forest or in monoculture in the Trung Khanh district of Cao Bang province. A related species, *Castanopsis indica* Roxb., is distributed in evergreen forests of Ha Bac, Vinh Phu, Quang Tri and Langbian at 500-1,500 m above sea level and produces a popular nut (22).

Other edible wild species of *Fagaceae* are: 1) *Castanea boisii* Hick & Cam., a 10-15 m tall tree with solitary female flowers which turn into prickly ovoid nuts with their thorns arranged in a comb like fashion, 2) *Castanopsis dongchoensis* Hick & Cam, a 20 m tall tree that has fruits on spikes, with prickly, straight groups of thorns, 3) *C. lecomtei* Hick & Cam, a 30 m tall tree with prickly fruits that are about 4.5 cm wide (including the length of its thorns), 4) *Lithocarpus corneus* (Lour.) Rehd., a 9 m tall tree with inflorescences that are either unisexual or hermaphroditic. Its fruits are covered with scales and yellow pubescence, 5) *L. dealbatus* (Hook. f.) Rehd., a tall tree that has pubescent fruits, about 2 cm, with concave scarred marks, 6) *L. haemispherica* (Drake) Cam., a deciduous tree that is 12-15 m tall with hemispheric fruits that are covered with triangular scales.

Elaeagnus conferta Roxb. is an important species of *Elaeagnaceae* found both wild and cultivated in northern Vietnam. Its flowers are apetalous and its red fruit are about 10-25 mm and hairy (2). The fruit are consumed fresh, cooked in soup or used to make candy (22). Nine other species of *Elaeagnus* are located in the high mountains of North Vietnam. These are: *E. bonni* Lec., *E. conferta* subsp. *balansae* Servellaz., *E. delavayi* Lec., *E. gonyanthes* Bent., *E. loureii* Champ., *E. sarmentosus* Rehd., *E. tonkinensis* Serv. Two other species, *E. fruticosa* (Lour.) A. Chev. and *E. conferta* subsp. *mollis* Lec. are found in Dong Nai and Hue, respectively (12).

At least 2 species of *Myrica* (*Myricaceae*) have edible fruits that are utilized in Vietnam: 1) *Myrica sapida* Wall. This medium sized tree has flat, red fruits that have 2 rows of hairs when ripe. Its sweet and sour fruits are used to make wine (22), and 2) *M. esculenta* var. *chevalieri* (Dode) Pham-hoang, Strawberry-Tree, a variable sized tree, with sweet and sour red berries that are 8-12 cm wide, and var. *tonkinensis* Chev., a small tree that has red berries on terminal panicles (13).

Several relatives of the kiwi, *Actinidia* (*Actinidaceae*), are found in Vietnamese forests. The edible *A. latifolia* (Gardn. & Champ.) Merr. is a dioecious climbing vine with sour, many-seeded berries, covered with brown appressed hairs and embraced by remnants of sepals. A related species in the same family, *Saurauja nepaulensis* DC, is also utilized for its kiwi-like berries.

There are two important *Prunus* species (*Rosaceae*) located in Vietnam: 1) *Prunus cerasoides* D. Don, a small deciduous tree that has elegant flowers with long petals and pedicels. Its sparsely spaced flowers, arranged on corymbs, symbolize the spring season and New Year in northern Vietnam. It has red, sour drupes that are about 1 cm wide, and 2) *P. cerasus* forma pleno, a small, cultivated tree that has *shiny* black branches. Its large, 3-4 cm

wide, fragrant, pink flowers with red stamens are strikingly beautiful (11).

A number of other edible, native *Rosaceae* fruits serve as an important source of vitamins to local people including: 1) the native strawberry, *Fragaria nilgerensis* Schlecht ex. Gray, a stoloniferous, perennial that has berries which are white or pink, 2) the wild apple, *Malus doumeri* (Beis.) Chev. Gan., a 30 m tall tree that has yellow, fragant fruits with a smooth flesh, 5 chambered ovaries and 1-2 seeds, 3) *Rubus obcordatus* (Franch.), a climbing or standing shrub that has yellow fruit, 4) *R. multibracteatus* Levl. & Van., a shrub or climbing vine that has thick, pubescent, yellow cymes and white flowers. Its red, fragant fruits are said to be particularly tasty, 5) *R. alceaefolius* Poir., a climbing vine that has white flowers with 30 carpels arranged on racemes or corymbs. It has red, sour fruits and its leaves are used as tea, 6) *R. pyrifolius* Sm., a small crawling or climbing tree that has succulent, red fruits, 7) *R. corchorifolius* L., a shrub with tasty red fruits, and 8) *R. reflexus* Ker. (11).

Conclusions

A wealth of native fruit germplasm exists in Vietnam. It is likely that they offer opportunities for agricultural development. The country is now primarily a rice exporter, but there are signs that farmers are shifting to other commodities that might bring higher returns. In the Mekong delta, the cultivation of citrus and other fruit crops is becoming increasingly popular, and the traditional system of Vuon Ao Chuong; meaning, Gardens (Vuon) for fruits, Ponds (Ao) for fish, and Barn (Chuong) for animal husbandry; is being rediscovered and promoted nationwide. It is an excellent example of how small scale sustainable development can increase income of small and medium farmers, while conserving the environment.

A coordinated, nationwide effort is needed in Vietnam to promote their native fruit crops. Their development will help expand export markets and strengthen domestic markets. Their perenniality will also likely reduce environmental damage to Vietnam agriculture. Fruit crop development is particularly suitable for the Vietnam highlands where the ethnic minorities are concentrated. Such an initiative, of course, requires implmentation to ensure that farmers have food security until they can enjoy the return of their long-term fruit crop cultivation.

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Sweet Cherry and Adaptation to Mild Winters

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Abstract

The response to marginal winter chilling accumulation of six sweet cherry cultivars was evaluated as well as the use of hydrogen-cyanamide as a dormancy braking agent to regularize the bud opening and its impact on fruitfulness and quality. Bud sticks were collected at a cherry orchard located in Northwest Mexico, treated with cyanamide at 1, 2.5 and 3.5 % and forced to sprout. Based on the results, a dose of 2.5% of cyanamide was selected to treat groups of trees on two dates and with single and double treatments; cvs. Bing, Van and Stella showed a positive response to mild winters and dormancy breaking procedure being reflected on yield and good quality. 'Hedelfingen' and 'Emperor Francis' cultivars seems to be moderately affected by winter chilling reduction and 'Sam' cultivar had a very poor adaptability to such conditions and did not respond to cyanamide treatments.

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