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The Argan, ***Argania spinosa*** (see article page 3)

West Australian Nut and Tree Crop Association (Inc.)

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THE ARGAN: MULTIPURPOSE TREE OF MOROCCO

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Joseph Hooker and John Ball, writing of *Argania spinosa* (L.) Skeels, said that "this tree is rightly regarded as the most interesting vegetable product of Marocco, being confined to that empire and to a very circumscribed area in it, belonging to an almost exclusively tropical family, yielding a most important article of diet to the inhabitants, and a wood that for hardness and durability rivals any hitherto described" (Hooker & Ball, 1878).

More than a century later the argan continues to be of manifold interest; to the botanist and ecologist because of its apparent Moroccan endemism and its disjunct distribution in relation to its family, the Sapotaceae; to the food technologist because of its highly nutritious oil whose untapped commercial potential is hindered by problems with its extraction; and to foresters and local inhabitants because of its central role as a stabilizer of soil and as a source of fuel and food for goats. There must now, however, be added a further interest in the argan: a grave concern for its future.

"The earliest account of the Argan tree known to us", wrote Hooker & Ball (1878), "is a brief one by the celebrated African traveller Leo Africanus, who visited Marocco in 1510."Speaking of some of the customs of the Moors, Leo Africanus says: 'Unto their Argans (for so they call a kind of olive which they have) they put nuts; out of which two simples they express a very bitter oil, using it for a sauce to some of their meats, and pouring it into their lamps',

The next significant record is by Commelin (1697) who included an illustration apparently of an argan sapling (at least it clearly shows the characteristic spines) based on a drawing by Jan Moninckx between 1686 and 1690 (Wijnands,1983) - indicating that the argan had been in cultivation during this period at the Hortus Medicus in Amsterdam, the first horticultural record in Europe. Commelin's name for the species, '*Lycio similis frutex Indicus spinosus, Buxi folio*', implied India as its origin, a mistake repeated by Linnaeus in his description of the species in 1737 when he applied the binomial *Sideroxylon spinosum* to the argan.

Sideroxylon L. was replaced with *Argania* by Roemer & Schultes in 1819, and to this day *Argania* is monospecific. In 1854, a landmark in the history of the argan was reached with William Hooker's comprehensive account of the plant and its economic uses (Hooker, 1854). He was able to publish the first drawings of flowering material and can be credited with opening the modern era of argan study and appreciation.

In the meanwhile, the argan was enjoying some sort of a career as an ornamental plant. Perhaps it was introduced from Amsterdam to Britain where it was first recorded as being in cultivation with the Duchess of Beaufort at Badminton in 1711 (Aiton, 1789). Loudon (1838) said it "is occasionally met with in collections. It will stand our winters as a standard, but thrives best against a wall . . . A large plant against the wall, in the arboretum of Messrs. Loddiges, flowers abundantly every year. There are plants in the Horticultural Society's Garden, and in the Hammersmith and other nurseries. The argania thrives in a sandy loam, and is generally propagated by layers. Price of plants, in the London nurseries, 5s. each".

In addition to layering, propagation may also be achieved by cuttings in autumn or spring in a closed frame with gentle heat (Chittenden & Synge, 1956). One of us (H.D.V.P.) collected some argan fruits near Agadir in June 1990 and germinated them easily enough on a substrate of 1 per cent agar in a 26°C growth cabinet. A dozen small plants, some 20 cm tall, are now growing well under glass at Wakehurst Place and with an imminent move to the temperate nursery at Kew may eventually have the chance to attain their maximum height of about 10 metres.

These plants already show some of the characteristic features of the mature trees. The leaves are simple, oblanceolate and leathery, subtended by spines nearly 1 cm long. In Morocco the insignificant flowers appear from April to May in small clusters in the leaf-axils; they are greenish white and 5-6 mm in diameter. Fruits develop slowly and may take up to a year to ripen, so that in late April we have observed ripening fruit and flowers on the same tree. The fruits are lime-green when unripe and bright yellow when fully mature, with a shape that varies from nearly spherical to fusiform and a size usually larger than that of olives.

Most of the fruit consists of a very hard nut containing up to three seeds, while the surrounding pericarp has a thin fleshy layer and a tough peel.

As noted by William Hooker, the argan is un1,100 or so species in the Sapotaceae which are trees and shrubs of the wet tropics, but it is also the only species north of the Sahara. Both taxonomically and geographically its nearest relative is *Sideroxylon marmulano* Banks ex Lowe, a rare and endangered endemic of Madeira and the Canary and Cape Verde Islands. These Atlantic islands, along with the Azores and the tiny Salvage group, are floristically similar and belong to the biogeographic area known as Macaronesia, which also extends to parts of Morocco.

Peltier (1973) listed 29 species in the Moroccan enclave which are either Macaronesian endemics (i.e. also found on the islands but nowhere else) or endemovicariants (i.e. species like the argan which occur only in the Moroccan enclave but whose nearest relatives occur on the islands). The taxonomic diversity of these species (from 17 families) is mirrored by other groups of organisms with similar patterns of distribution, for example. insects (Evers, 1964). The centre of the enclave, the fertile Plain of Souss, also contains snakes, mammals and birds which are essentially of tropical origin, again like the argan (see Mellado, 1989).

The Plain of Souss lies between the two great mountain ranges of the High Atlas and Anti-Atlas. From here the Macaronesian enclave extends north to the fishing port of Safi

Argania spinosa. A, flowering branch, x 2/3; B, fruits, x 2/3; C, flower, x 4. Drawn by Margaret Tebbs

and south to Tarfaya opposite Fuerteventura, a distance of some 650 kilometres. Along the coastal strip the most obvious plants are succulent euphorbias, but inland it is the argan that strikes the eye in a wide variety of landscapes.

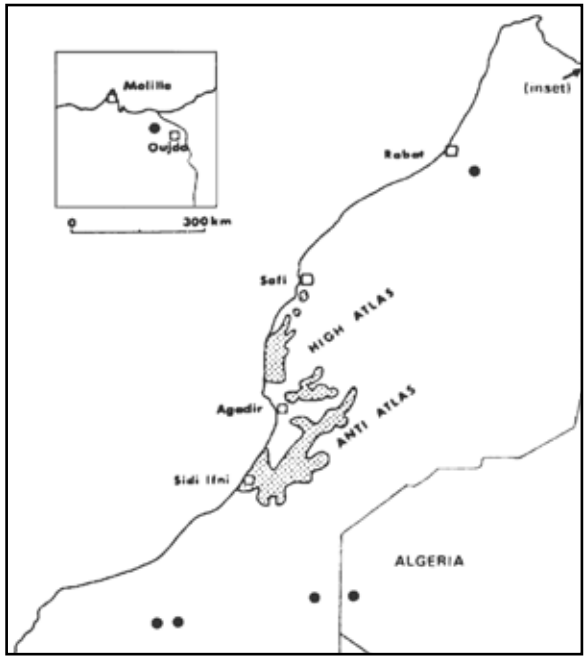
Estimates vary on how much 'arganeraie' (a convenient French word for describing the argan woodlands and forests) remains but its acreage in Morocco is only exceeded by that of the forests of *Quercus ilex* L. and *Tetraclinis articulata* (Vahl) Masters. According to Monnier (1965) the original arganeraie covered about 1,400,000 hectares but progressive clearance, including that of some 150-200,000 hectares in the century up to 1925, had reduced this area by half. Boudy (1950) reckoned that 200-250,000 hectares had disappeared from between Safi and Essaouira alone in the previous 150 years and it certainly no longer occurs round El Jadida where it was seen by Emberger (1925).

A 1976 government forestry map of Morocco indicates a total arganeraie of 828,000 hectares, whilst Benchekroun & Buttoud (1989) state "un peu plus de 600,000 ha". Overall average density too has declined, from 45 trees per hectare in the 1950s to about a third of that in the late 1980s (Benchekroun & Buttoud, 1989). These authors also remark that the arganeraie now looks everywhere more like an orchard than a proper forest.

A similar impression in fact had struck Joseph Hooker a century earlier on his tour of Morocco and the Great Atlas (Hooker & Ball, 1878): "the Argan trees were nowhere so near together as to form what could be called a forest, but scattered in small clumps or single trees over the surface, so that nothing but a carpet of green turf was wanting to complete the resemblance to an English park".

Round Tamanar, the self-styled argan 'capital' (although the species actually derives its name from the town of Argana to the south east), the relatively high average annual rainfall of about 400 mm allows the trees to attain their maximum size. Some are 10m high and have a deep and rounded canopy which can vary from 20 to 40 m in diameter. They may be single trunked or have a number of stems spreading out and rising from near the ground rather like the 'mallee' eucalypts of some parts of Australia. At the southern limits of its range, however, in oueds (riverbeds) of the Sahara which receive as little as 50 mm annual rainfall, the argan is a low, stunted and almost branchless shrub.

Apart from deep sand, the argan tolerates most soil types within its range. It is common from sea level up to the lower limit of snow at about 1,500 m in the High Atlas. Emberger (1925) established that this altitudinal limit corresponds with the average monthly minimum temperature of the coldest month, namely the 3.8 °C isotherm. In the Anti-Atlas the effect of this isotherm is gradually replaced by that of minimum humidity which is the limiting factor further south.



The distribution of Argania spinosa. *Shaded areas indicate the main distribution; black circles - outlying populations*

Exactly how far the argan penetrates the Sahara is difficult to discover but a good clue can be obtained from maps of the frontier region between Algeria, Morocco and the disputed territory of the former Spanish colony of Western Sahara. As noted by Boudy (1950) the argan appears in many topographic names: in Oued Targant. Oued Argan, Bou Argana and Argann, a settlement some 65 km west of the Algerian town of Tindouf. The argan does cross into Algeria, but only just (Benmalek & de la Perriere, 1991). These remote southern outposts survive in the Sahara by growing in the oueds, their relictual status owing less to modifications by man (and goats) than to long-term climatic changes since a distant and more humid past. Far to the north, however, there are even more isolated witnesses to such changes: firstly, a pocket of argans in the oak forest of Oued Grou near Rabat, and secondly, a further 450 km north eastwards, another pocket on hillsides at Beni Snassen close to both the Mediterranean coast and the Algerian frontier. This remarkable outpost, not discovered until 1925, was studied by Maire (1939). "Tout-a-fait aberrante", he wrote about it although he also recorded other essentially south-west Moroccan species in the same place which have a relictual status in the north east and even, in some cases, the Iberian Peninsula as well. One of these is *Tetraclinis articulata*, a co-dominant of the floristic association to which the Beni Snassen argan population belongs (Benabid, 1984).

As Sunding (1979) has summarized, most of the endemic Macaronesian species must be considered relicts of the humid subtropical flora that covered Europe and part of North Africa until the Miocene and Pliocene periods beginning about 25 million years ago. Evidence for this has been the identification in many south European localities of plant fossils identical to or very like extant taxa (see species list and Fig. 15 in Sunding, 1979). As far as the argan itself is concerned, the story seems to have been neatly completed by the discovery in the late 1970s of the fossil tree *Arganioxylon sardum*, whose silicified wood fragments from a Miocene formation on Sardinia bear a remarkable resemblance to those of the argan (Biondi, 1981). In view of all this, the argan may indeed once have grown near Kairouan in Tunisia as tentatively reported by Ehrig (1974) and one cannot but wonder whether an undiscovered population still lurks somewhere in the extensive Atlas mountains of Algeria between there and Morocco.

Joseph Hooker appears to have been the first botanist from Kew who saw the argan in its native habitat, but not the first to have studied it. In an era when the Gardens had an important role as a finder and provider of economically important plants for the Empire, his father William received from the British Vice-Consul in Essaouira (then called Mogador) some living argan plants and seeds. He wrote (Hooker, 1854): "we have been at some pains to distribute the seeds of this plant, with which we have been liberally supplied, to various parts of the East Indies, and to such of our colonies as appeared suited to the growth of this tree, in respect of climate, etc."

Birdwood (1878-9), however, clearly went a bit too far in suggesting that "it is probable that the Argan tree also will flourish in India everywhere, but most in sub-Alpine tracts exposed to the sea breeze and an annual rainfall of from 50 to 25 inches"! The Americans too had a busy consul, a Mr Sprague based in Gibraltar, who in 1910 sent the United States Department of Agriculture some argan seeds (United States Department of Agriculture, 1911 a & b). In general the argan seems to be an awkward tree to grow out of its native environment and the only successful large-scale introduction known to us is in Israel where Ben Gurion University has plantations of about 100 trees (now five years old and beginning to bear fruit; Prof. Y. Mizrahi, in litt.).

"When I tried to think of some substitute for the argan tree that could be introduced and be worth more to the Berbers", wrote an American visitor to Morocco in the 1920s (Fairchild, 1931, quoted by Morton & Voss, 1987), "I saw how difficult it would be". It would indeed, given both the argan's abundance and dominance where it occurs and the dependence on it by the local population for a number of reasons. It has an excellent timber - denser than oak's and stronger than that of any other native tree - and makes a charcoal much more highly prized than that of the ubiquitously planted eucalypts.

Despite an armament of thorns, argans are also heavily browsed by goats which - an extraordinary but common sight - climb to the very tops of the trees to browse the youngest and freshest shoots. So important is the argan to hundreds of thousands of goats that there are even technical terms, 'hanging' or 'tree meadows' (Metro, 1958 in Ehrig, 1974, and Glatzle, 1990 respectively), to describe the scene of this arboreal activity. At summer's end and during drought the argan is often literally the only plant around that even goats can eat; sheep simply starve. Overgrazing, timber extraction and felling for new agricultural practices all pose threats to the argan. There is a further feature about the species, however, that may slow or reverse its demise.

Anyone travelling in June through the province of Tamanar is sure to encounter small Berber boys beside the road holding up oil-filled bottles for sale to passers by. This is argan oil. It is darker than olive oil, the main cooking oil in Morocco as a whole, but which it replaces in this area. It has a rich flavour and a smell reminiscent of peanut butter, and has been the subject of considerable biochemical analysis. About 80 per cent of its fatty acids are the unsaturated acids oleic and linoleic (the latter being an essential fatty acid which cannot be synthesized by humans and so must be obtained from our diets) (Huyghebaert & Hendrichx, 1971; Farines et al., 1982). Compared with olive oil, argan oil has more unsaturated acids as a whole, being richer in linoleic, but poorer in oleic, acid (Manousis & Moore, 1988) and so is nutritionally more beneficial.

Even at the roadside the oil costs 25 dirhams (£1.50) a litre (more than the daily wage of an agricultural worker) whilst in the supermarkets of Rabat it is not only twice as much (and watered down) but also three times the price of the most expensive olive oil. Outside its immediate range it is clearly a luxury item. The fruits from which the oil is extracted are picked either fresh from the ground or after they have passed through goats which digest only the fleshy and highly nutritious outsides.

Argan trees often grow in groups of three to ten, eventually forming a broad, compound canopy. Near Agadir. From Morton, 1987

Goats, which foresters have called 'black grasshoppers', feast on argan foliage and flesh of fallen fruits. From Morton, 1987

It is the seed, enclosed within an extraordinarily hard husk, that contains the oil. On a national scale, extraction of this oil occupies between seven and eight million working days a year. This exceptionally laborious process, usually undertaken by women, involves breaking open the husk, heating the seeds and then crushing and grinding them between specially shaped stones. Every litre of oil produced needs ten hours work (Dr M. Rahmani, pers. comm.). If ever a process merited mechanization, this is it! The Natural Resources Institute at Chatham (part of the Overseas Development Administration - ODA) is collaborating with local colleagues to design a low-technology method for extracting the oil (Head, 1989). Given that the oil is so highly prized, any labour-saving method could well contribute to a better future for the argan, especially if modern plant breeding and selection techniques are also applied.

What else can be done? In flat areas like the Plain of Souss, where argans are being cleared to make way for agriculture, Benchekroun & Buttoud (1989) propose that they should be planted in the hedges which already surround many fields but which currently consist of other species (such as acacias). Similarly, on steep terrain they could be planted in lines crossing the slopes which would allow both agricultural activities and a greater density of trees. Solutions like these are desperately needed and are symptomatic of the increasing concern for the species.

Since this article was prepared (January 1991), a special conference on the argan was held in Agadir. Most of the participants were Moroccans, with an additional complement of outsiders from various disciplines. As we have pointed out, there has been outside interest in the argan for centuries. It continues today: the French company Galenic, for example, produces cosmetics from argan fruits and, on the research scale, ODA's German equivalent (Gesellschaft fur Technische Zusammenarbeit) may soon start funding projects on the species. There are many others too, like ourselves, who have fallen under the spell of the argan - truly Morocco's wonder-tree!

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THE BAEL

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Introduction

Common and regional names

The bael (*Aegle marmelos* Correa) is known as Wood apple or Bengal Quince in the English language; as *bel, bela, sirphal,* Golden apple, Indian quince, Holy fruit, Stone apple in India; *oranger du malbar* in French; *marmelos* in Portuguese; *bilak* or *maja pahit* in Malaysian; *madjo* in Java; *bau nau* in Vietnam; *phneou* or *pnoi* in the Cambodian language; *malum* and *mapin* in Thailand. Other synonyms of *Aegle marmelos* Correa are *Feronia pellucida* Roth and *Crataeva marmelos* L.

Origin and distribution

The bael is an Indian native plant, which is also found in Burma, Pakistan, Bangladesh, Sri Lanka, Thailand, and various other parts of Southeastern Asia.

Historic mention of bael fruits has been traced to Vedic times (2000-800 BC). It has been considered as a sacred plant by Hindus and commonly grown in temple gardens in India. It has been stated that this tree indicates the presence of water. It was introduced into Europe from India in 1759.

Traditional and medicinal uses

The bael has got nutritive, curative and pesticidal properties. All of its parts, i.e., stem, bark, leaves, fruits, and roots at any stage of development, have one or another usage. The unripe as well as ripe fruits can be used in different ways, mainly making '*murabba*' (sweet preserve), jam, candies, toffees, slabs, and soft drinks. Sundried fruit slices of green fruit are often stored for future use. The fruit pulp can be used for washing clothes.

The gum from unripe fruit is used as glue as well as a protective coating on paintings. The medicinal properties of this plant has been described in 'Charaka samhita' an early Sanskrit medicinal treatise. For medicinal uses, young tender fruits are horizontally cut, and sun dried. Major constituents are mucilage and pectin in unripe fruit, while ripe fruit is a tonic and is used as mild astringent for diseases like diarrhoea and dysentery.

Many alkaloids, coumarin and steroids have been isolated from different plant parts. The pulp contains psoralen, which is employed in treatment of leucoderma; another compound, marmelosin, is used as a laxative and diuretic. Fruit is claimed to be prescribed in case of hepatitis and tuberculosis in Cambodia. Aqueous and alcoholic extracts have cardiotonic effects on amphibian and mammalian hearts. A decoction of flowers is used as an eye lotion. A bark decoction is sometime given for curing malaria. A leaf decoction is effective in relieving asthma, extracts from leaves in combination with honey are good for catarrh and fever, adding black pepper relieves jaundice.

All plant parts have antibiotic properties. Roots are used as an anti-inflammatory and antidote to snake venom in India. The leaves have got pesticidal constituents. Although the wood is not durable, it is good for carving and making handles of various tools.

The Bael, Aegle marmelos [From: Edible Fruits and Nuts, PROSEA 3]

Nutritional value

The bael is a rich source of riboflavin and is a highly nutritious and flavoured fruit. On a 100-gram pulp basis it contains 61.5% water; 1.8 g protein; 0.39g fat; 1.7 g minerals; 31.8 g carbohydrates; 55 mg carotene; 0.13 mg thiamine; 1.19 mg riboflavin; 1.1 mg niacin and 8 mg ascorbic acid. Its seed contains 62% protein; 32% oil (15.6% palmitic acid, 8.3% stearic acid, 28.7% linoleic acid and 7.6% linolenic acid); 3% carbohydrate and 3% ash content.

Toxicities

Some wild species contains about 9% tannin in pulp and up to 20% in rind. High tannin ingestion over extended periods act as an anti-nutrient and may be carcinogenic. Leaves can cause abortion in women and bark is used as fish poison.

Botany

Taxonomy and general description

The bael belongs to family Rutaceae, orange subfamily Aurantiodae, tribe Clauseneae and subtribe Balsamocitrine. Its generic name *Aegle* is Greek while the species name *marmelos* is of Portuguese origin. It is a medium size (6-8 metres), deciduous woody tree, with trifoliate aromatic leaves.

Morphology and biology

The plant has unusual branches bearing straight spines. The bark is shallowly furrowed and corky. The leaves have three leaflets, terminal usually being the largest. The flowers are bisexual, nearly 2 cm wide, white, fragrant, borne in clusters of 4-7. Its shallow calyx has 5 short, broad teeth, pubescent outside. The flower has usually 5 petals (rarely 4) of a pale greenish white colour, dotted with oil glands, and 50 or more greenish yellow stamens, sometime coherent in bundles. The ovary is oblong, ovoid slightly tapering, with 8 -20 cells - numerous cells in each ovary. Fruits are globose, round, pyriform, oval or oblong, 5-20 cm in diameter, with greyish yellow pericarp (3 mm thick) and sweet pulp, yellow to orange in colour. Seeds are numerous, compressed, closely packed and arranged in the cells surrounded by transparent mucilage, which on drying becomes hard. The white testa has woolly hairs and the embryo has large cotyledons.

Culture

Soil and Climate

The bael is a sub-tropical plant with high adaptability of agro-ecological conditions up to an altitude of 1200 m. It grows from arid to swampy conditions and in areas with pH range of 5-10 and temperature of 6-49°C. It will not bear fruit if there is no prolonged dry season, as in Southern Malaya.

Cultivars

Previously most of the bael cultivars in India were named after the locality in which they occur. 'Mirzapuri' was the best choice. Other were 'Darogaji', 'Ojha', 'Rampuri', 'Azamti' and 'Kamaria' in the ranking order. Another good variety 'Kaghji Gonda' had fruit of 1412.82 grams with very thin rind (0.15 cm).

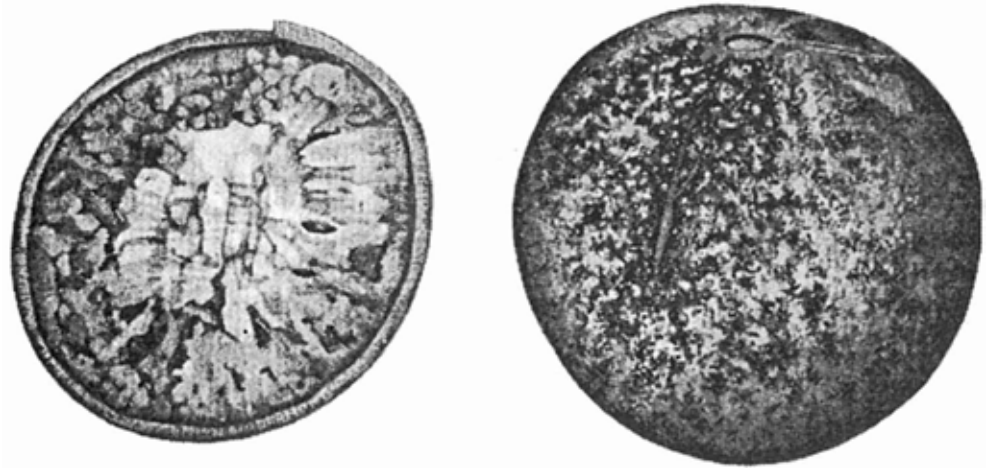
In a survey of Uttar Pradesh province in India, data on 7 varieties gave a TSS (total soluble sugars) range from 28 to 36%, reducing sugars from 2.7 to 5.2%, non-reducing sugars from 8.3 to 12.4%, total sugars from 11.7 to 16.9%, acidity from 0.256 to 0.368% and vitamin C from 13.4 to 22.7 mg/100 g.

It has been suggested that the organoleptic quality of bael fruits mainly depends upon three factors, i.e. sugars, mucilage, and total phenolics. The cultivars with higher sugar content, especially the non-reducing sugars, and low level of phenolics, are good in taste. Size of fruits is also very important as the larger size fruits have high pulp, comparatively thin peel, and lower seed, mucilage and phenolic.

Potential bael cultivars with regard to fruit productivity and quality have been selected and current popular selections are as below.

NB 5. Fruits are medium sized, round with smooth surface at maturity. Other characteristics include low mucilage contents, moderately fibrous, soft fleshed with excellent taste.

NB 6. Fruits are medium sized. round having smooth surface, thin rind, few seeds, low mucilage and mild acidic.



Cross-section and whole fruit of Bael [from Alan Davidson: Fruit, a connoisseur's guide]

Pant shivani. This is a mid-season cultivar with heavy fruits (2 kg) ovoid oblong shape. Mucilage and fibre contents are low. Fruit rind has medium thickness; pulp colour is light yellow with sweet taste and good flavour.

Pant Aparna. A late maturing cultivar with small fruit size (0.6- 0.8 kg), medium thick rind, globose in shape having less number of seeds. Mucilage, fibre contents and acidity is low. It has yellow flesh which is sweet, tasty and of good flavour.

Propagation

Bael is propagated through seeds, which are recalcitrant and cannot be stored for a long period in normal storage. Plants produced from seeds are rarely true to type. Budding (patch or shield) during June-July gives good success. Budwood should be taken from one-month-old shoots. Air layering in the tropics and use of root cuttings is also successful. In-vitro propagation has also been standardized, though commercially not applicable.

Seedlings start bearing at 6-7 years of age, vegetatively propagated plants bear in 4-5 years, and full bearing potential can be attained in 15 years. The bael has graft compatibility with related plants, eg *Aegle fraeqlegabonesis, A. chevalier, A. paniculata* and *Swinglea glutinosa*. Grafting of oranges on seedling of bael fruits has also proved successful.

Top working can successfully rejuvenate old plants. During experiments in India, 11, 8 and 5-year old plants were cut back to 4 feet from the ground in March and only 10, 9, and 8 new shoots were retained respectively. These were shield budded with improved scions in the following June. The percentage success was 90, 100 and 87.5 % respectively, and trees started bearing fruits in 5 years.

Planting distance

There is no recommendation regarding planting distance or method of planting of bael fruit. However, methods adopted in citrus cultivation can also be adopted for bael. For planting as an orchard, plants should be spaced 10 metres apart for getting good plant growth and fruit yield.

Pruning and training

Trees can be trained in the modified central leader system. Pruning should be done twice in a year, aiming at removing dead and diseased branches during May, while in August healthy leaves should be pruned off for sale purpose.

Nutrition

Deficiency of nitrogen and zinc has been reported from bael plants, and can be easily corrected by soil or foliar application of required nutrients in the form of fertilizers.

Pest and diseases

The most common insect pest includes citrus leaf minor (*Phylocnistis citrella*) while fruit canker, gummosis, and bacterial shot hole are the major diseases. The symptoms of bacterial shot holes caused by *Xanthomonas bilvae* on leaves are round, watery spots, 0.5 mm in size, surrounded by a hole. This spot reaches in size from 0.3 mm to 0.5 mm and will form a brown lesion. There is a depression in its centre surrounded by an oily, raised margin. The dead tissue falls, creating shot holes on the leaf surface. Such lesions occur all over the leaf. Fruit-cracking just before ripening is a physiological disorder in some genotypes of bael.

Fruit ripening, harvesting and yield

Generally it takes about 11 months from fruit setting to harvesting in the bael plant. Under Delhi conditions (India), fruit setting occurs in early May. Fruit approaches maturity during December, but due to prevailing low temperatures, ripening is delayed until the following April.

Fruits are considered to be climacteric in nature, but no climacteric rise in respiration occurs as long as the fruit is on the tree. During ripening, the peel turns very hard and brittle. Moisture content, acidity, and total phenolics decrease while dry matter, pectin, crude protein, total and reducing sugars are increased. Exogenous application of ethylene along with high temperatures accelerates the ripening process. The fruit can be picked up to 2-3 months early and ripened artificially in 18-24 days by treating with 1000-1500 ppm ethrel (2-chloroethane phosphonic acid) at 30°C. With artificially ripened fruits, total sugar contents are lower.

Due to its deciduous nature the tree has no leaves at ripening time. Fruits are manually harvested along with their stalk, when colour changes to yellowish green. Tree shaking is generally discouraged, as the fallen fruits are likely to develop cracks and later on get infected. Care must be taken to avoid causing skin cracking during harvesting operations.

Yield depends upon age and cultivars but 200-400 fruits per tree is common at 10-15 years and 400-1000 fruits have been harvested from full-grown seedling trees (40-50 years old).

Shelf life

Fruits are generally transported in gunny bags, and wooden crates without any packing material, but use of any kind of cushioning material is highly desirable. Fruit can be kept for 2 weeks at 30°C and 4 months at 9°C. At low temperatures (below 9°c) chilling injuries (brown spots on fruit surface) occur, while at high temperature (above 13°C) fungus spoils the fruit. In case of extended storage, mould can develop in cracks of the rind as well as at the stem end of fruits. It is advisable to use some kind of cushioning material for packing of fruit to avoid skin injuries, which results in heavy fungal infection.

Processing

Bael fruit is very important for the processing industry because it gives high yields of pulp. The total soluble solids content of bael fruit are about 40 %, comparable with many other fruits.

Use of mature green fruit as well as ripened fruit has been widely reported in preparing preserves, but due to high gummy principles it did not form jelly, although fruit is rich in pectic substances. For preparing preserves from mature green fruit, the rind is removed and fruit is cut into two halves and thinly sliced. After washing with water, slices are pricked with a fork and kept overnight in cold water, blanched, and put in sugar syrup. The syrup strength gradually increases to 700 Brix.

Ripe fruit is not much consumed due to eating difficulty. With conventional methods of pulp extraction, pulp gets off-flavoured and colour changes due to enzymatic activities.

However pulp can be extracted with an equal amount of water at pH 4.3 with citric acid (titratable acidity 0.5%) at 80°C for one minute, and afterward passing through a pulping machine. The pulp extracted by this method has almost the same consistency as that of mango. The extracted pulp can be improved by adjusting Brix of pulp to 25% by addition of sugar without altering acidity. Canning, freezing and addition of $S0_2$ can preserve it for different uses.

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PUMMELOS IN CALIFORNIA

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The Sunday before Chinese New Year, last February, a crowd gathered well before the opening of the Alhambra farmers market, in a mood somewhere between festivity and riot. As Jerry Dimitman drove up in his truck loaded with gigantic pear-shaped pummelos, the all-Asian throng surged forward, arms outstretched, waving money, shouting, pleading, bouncing off each other as in a mosh pit.

Amid this frenzy, Dimitman and his two sons heaved cartons, sold their precious yellow gold fruit, and tried to protect the smaller customers from getting trampled. As supplies dwindled, a wiry teenager grabbed a case off the truck and ran. After 25 minutes, only leaves remained, which several women reverently picked up and saved.

Why such commotion over what looks like an overgrown, prehistoric grapefruit?

For many Asians, pummelos stir deep cultural resonances. The Alhambra crowd sought pear-shaped, white-fleshed pummelos, which are common in China, but rare in California, where the round, pink-fleshed Chandler variety predominates.

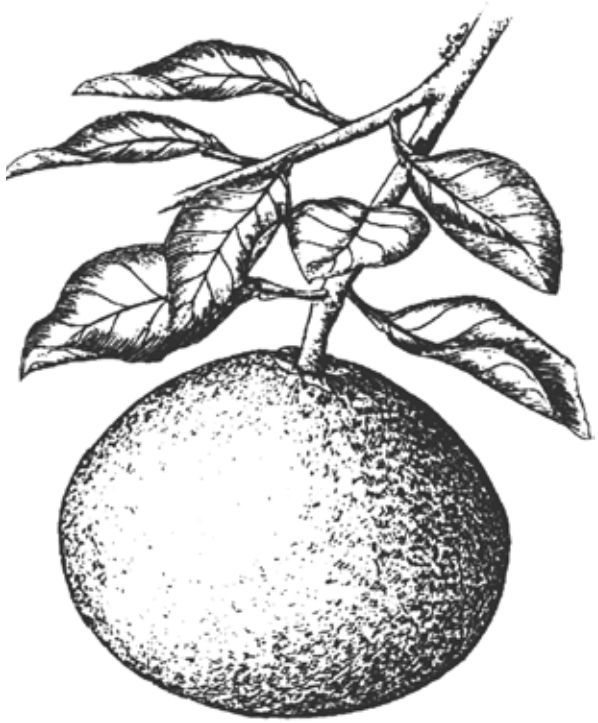
"People want the original Chinese pummelo," explained a young Vietnamese man helping the Dimitmans. "It symbolizes good luck and plenty." The elephantine size of pummelos often draws stares from the uninitiated. Produce packers measure citrus by the number of fruits that fill a standard carton; whereas grapefruits average in the 30s, typical pummelos range from 6 to 14 - and 1s, basketball-size behemoths weighing over 9 kilograms, are not unknown.

Although pummelos vary widely in form, most have thick rinds, which can be green or yellow, depending on season and climate. Whether smooth or pebbly, they smell sweetly of orange blossoms and lemon peel, with a hint of gardenia.

Pummelos are less tender and juicy than grapefruits, but the best pummelos compare favourably with the best grapefruits. Most pummelo pulp tastes mildly sweet, and is delightfully lacking in naringin, the chemical compound that makes grapefruit bitter. Naringin abounds, however, in the spongy pith and tough membranes, which must be completely removed before the segments can be eaten. This is easier than it sounds, since the segments have a firm texture unique among citrus, with large juice sacs that hold together without bursting.

The Grapefruit's Grandfather

The pummelo (pronounced puh-mellow), *Citrus maxima*, is one of three original species of citrus, along with the citron (*C. medica*) and the mandarin (*C. reticulata*); all the rest, including oranges, lemons, and limes, arose as hybrids and mutations of the first three. Indigenous to Southeast Asia or southern China, still the areas of its greatest commercial and cultural importance, the fruit has grown wild in China for thousands of years, and a Confucian text relates that around 2200 BC, the Emperor Yu received a bundle of pummelos as tribute. The finest pummelos traditionally came from marshy deltas, where they were cultivated on beds raised above irrigation canals; farmers believed that brackish water improved the fruit's quality.



The pummelo. Note winged leaf stalks [from: Fruits (Indonesia), IBPGR]

It is uncertain when pummelos spread westward to India and the Middle East. In the second half of the 12th century, a Christian pilgrim to the Holy Land and an Arab writer in Spain described large citrus fruits called Adam's Apples (supposedly bearing the imprint of Adam's teeth), which some scholars claim were pummelos. However, these may well have been lumias, little-known hybrids of pummelo and lemon or citron, still grown in the Mediterranean basin.

In the mid-17th century a semi-legendary English sea captain, (only recently verified as a historical figure, Phillip Chaddock), brought pummelo seeds from the East Indies to Barbados, where the settlers started growing the fruits, calling them shaddocks.

In the next 100 years these shaddocks hybridized with sweet oranges to produce the ancestors of the modern grapefruit, first known in the West Indies as the forbidden fruit, or lesser shaddock. (Long thought to be extinct, these proto-grapefruit were rediscovered a decade ago on the island of Saint Lucia.) All modern grapefruit - so called either because they hung in bunches like grapes, or supposedly tasted like grapes - derive from a single example brought to Florida in the early 19th century.

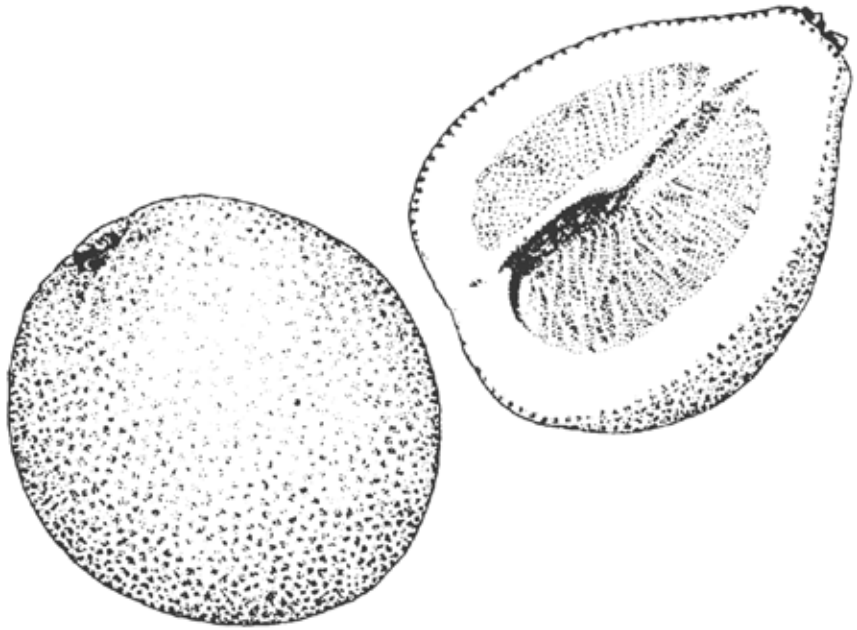
Many early growers considered grapefruit to be a form of shaddock. Confusion between the two persisted into the late 19th century, when agricultural authorities tried unsuccessfully to replace the ludicrous word "grapefruit" with "pomelo," derived from the Dutch pompelmoes. meaning "big lemon." Because "pomelo" is still sometimes used as a synonym for grapefruit, "pummelo" is now the preferred spelling for the original fruit.

§ Member, WANATCA

Chinese miners and labourers brought pummelos to California during the Gold Rush, and a Los Angeleno named Manuel Requena grew them in 1858. But these were seedlings, and since pummelos, unlike most citrus, do not bear true from seed, the fruits were mostly dry, bitter and seedy. "They are matters of wonder and that is all," noted Spalding's citrus treatise in 1885. George Toy, 94, lives in a house shaded by 11 pummelo trees, amid the last remnants of Bakersfield's old Chinatown, once the third largest in California. Standing next to a 12- metre tree planted by his mother in 1928, he clutched a large pear-shaped fruit, and recalled how pummelos served as a link to the homeland for his family:

"My father arrived in San Francisco from southern China in 1875, when he was 10 years old. When I was a boy, we had a store just for Chinese people, who worked on farms and ranches, and as cooks and laundrymen. Everybody hated the Chinese - they'd catch me and beat me up. We used to get pummelos sent over by boat from China, for New Year's decorations. "

Pummelos still play an important role as ritual offerings in modern Chinese folk religion, and are considered to have magical properties. The southern Chinese word for pummelo, "yu," means "we have," said Clair Lin, the information officer at the Hsi Lai Buddhist temple in Hacienda Heights. "It's a very profound meaning, relating to health, money and luck." Since pummelos are large and golden yellow, they evoke gold, and lots of it. Pummelo leaves symbolize purity, and are soaked in water to make a ceremonial bath to ritually cleanse a person and repel evil. Many Chinese weddings include immersion in pummelo water, and newborn babies are often bathed in the auspicious liquid.



In some areas, such as Taiwan, pummelos ripen in August and September. Chinese place pummelos on their household altars for the Mid-Autumn or Moon Festival, on the 15th day of the eighth month, which usually falls in September or early October. "Yu" also sounds like words for protection and blessing, so pummelos, which can look rather moonlike, express the hope for the moon god's benevolence, and serve as a symbol of family unity. In most of China, pummelos mature in December and January, and they star most prominently in Chinese New Year's celebrations. For last year's festivities, James Lee, a wholesale produce dealer, served a buffet banquet at his home in Hacienda Heights, including sea cucumber, Hawaiian ham, grilled salmon and stir-fried greens.

Red-orange paper diamonds with the Chinese characters for "Good Luck" festooned the walls, as well as the giant pear-shaped pummelo that graced the household shrine. For more good luck, Lee handed guests envelopes containing crisp new money, along with Oroblancos, modern pummelo-grapefruit crosses, from a tree in his backyard.

This is one of several varieties, hybridized by citrus breeders, that helped establish commercial cultivation of pummelos and their hybrids in California. Early seedlings bore mostly inferior fruit; even after the best grafted Asian varieties arrived here in the first third of the 20th century, pummelos proved very specific in their climatic requirements. Without tropical heat and humidity, most didn't develop acceptable flavour until March or April, far too late for the Chinese New Year's market. Pummelos might have languished indefinitely, but the same feature that doomed seedlings to unpalatability - rampant cross-fertilization, resulting in variable quality offspring - provided perfect material for breeders' experiments.

The breakthrough came when Professors James Cameron and Robert Soost of the University of California at Riverside found that a Thai pummelo, the Siamese Sweet, imparted low acidity to its progeny. In 1961 they introduced the Chandler variety, a round pummelo with sweet, crisp pink flesh, which ripens by November in the Central Valley. Moreover, when grown in large blocks, it sets fruits with few or no seeds.

As Asian immigration to the United States increased in the 1960s and '70s, growers found that pummelos brought high prices. They planted small groves, mostly in Tulare County, in the San Joaquin Valley; in the last decade, cultivation has quadrupled to more than 500 acres.

In 1980 Cameron and Soost released the Oroblanco, a pummelo-grapefruit hybrid with wonderfully sweet, juicy, light-yellow pulp, which tastes like a grapefruit without the tartness; a similar cross, the Melogold, larger and more like a pummelo, followed in 1986, but didn't catch on like the Oroblanco.

The UC-Riverside Citrus Variety Collection includes some 50-odd pummelos gathered from around the world, and rows of promising new crosses. On a chilly late December morning, Ottillia Bier, who helps supervise the collection, walked with citrus knife in hand, seeking to sample the sweetest slices, from the lower part of fruit on the south sides of the trees.

"Tasting some of these pummelos fogs your mind, they're so sour and bitter," she said, with bemused resignation. But others, such as the Sarawak, with a thin rind, tender greenish flesh, and intense, well-balanced lime taste, reveal complex, interesting flavours.

Then there's the Cocktail grapefruit, an experimental pummelo-mandarin cross so sweet and juicy that it "escaped" from the collection when someone filched a piece of bud wood. Though it's mostly available at farmers markets, several commercial growers in the Central Valley have put in blocks. No one knows pummelos better than Bier's former professor at Cal Poly: Pomona, Jerry Dimitman. who grows 7 hectares of unusual varieties at his properties in Fallbrook and Covina.

On a sunny January afternoon, he showed a visitor around his Fallbrook grove. Now 79 and retired, he speaks in a hoarse whisper, since his voice mysteriously disappeared three years ago.

"I was the only Caucasian in a Los Angeles tong, before I was commissioned in the Navy during World War II," he said, as, coincidentally, artillery boomed from nearby Camp Pendleton. "I started collecting pummelos in the Philippines in 1944. Now I've got 30 varieties, down from 37. I experiment with them, take measurements, and then cut them down."

A few other growers raise white-fleshed, pear-shaped pummelos, but their fruits are dry and waxy. Through years of searching Asia, Dimitman has found varieties that not only look right, but taste good, such as the big Chongs and Wongs, named after Chinese friends, that drove the crowd wild at Alhambra. He also has the Sutter, an extraordinarily juicy, delicate and flavourful pummelo brought to California by Chinese coolies working on the railroads in the 1860s.

Many fruit collectors would like to take cuttings of his trees, but Dimitman, who affects an ornery eccentricity, won't let any wood out of his grasp. "No one gets it!," he rasped, before letting on, in his next breath, that his son Robert would inherit the rare pummelos, which will eventually go to UC-Riverside.

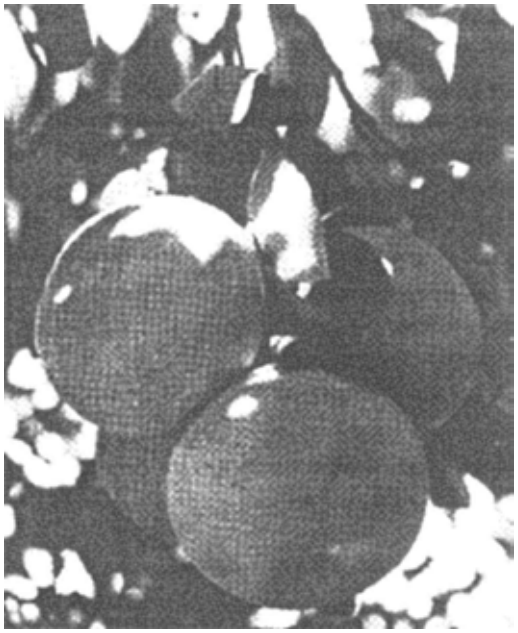
On one side of the road, exquisitely ripe Sarawaks plopped off the trees and tumbled down the steep slope. "Those trees are ready for the power saw," said Dimitman, who taught many of today's leading citrus authorities.

He sells his pummelos only to a few Asian-American produce sellers, and at the Alhambra farmers market, in the month before Chinese New Year; his stand is also mobbed whenever he brings in his Ponkan mandarins, longans and wampis. "I don't believe in commercialization," he said. "I do this because it's my passion. I do what I damn please, period!"

Other growers have to make a living. Though pummelos are still primarily an ethnic and specialty item, they are increasingly available at mainstream supermarkets.

"Once, it was the kiss of death to try to sell pummelos after Chinese New Year, but a broader demand has developed," said Mark Johnson, who markets specialty citrus for Sunkist, which handles 85 percent of the nation's crop. Recently, as pummelo supplies increased and prices dropped, farmers have cut back on new plantings. Oroblanco growers, however, face disaster. They put in several thousand acres, aiming to export most of the crop to Japan. But Israeli growers pirated the variety, calling their version the Sweetie, and flooded the Japanese market with earlier-maturing fruit.

To make life yet more difficult, last season a devastating freeze the week before Christmas blasted Central Valley citrus groves. On the afternoon of the third and coldest day, Harrison Smith, who has grown pummelos in Porterville since 1974, rubbed his eyes after a brief nap, and rode off to battle on an all-terrain vehicle.



Pummelos growing in Subiaco. This bunch weighed over 5 kg

As he activated his first line of defence, turning on the irrigation, Smith explained that fighting the freeze is a matter of a few critical degrees. Pummelos love temperatures around freezing, which turn the rinds bright yellow; they can tolerate -3°C; but after prolonged periods below this, they burst their juice sacs and dry out, ruined. The 16°C irrigation water, from deep wells, helps a bit.

Just before midnight, as the temperature dropped to -4°C, Smith sent his two teenage grandsons to light the orchard heaters. These cylindrical devices ("Don't call them smudge pots," he insisted. "Modern models don't pollute like the old ones.") burn expensive diesel fuel, but Smith gambled that they could save his pummelos, including a grove of tender young African shaddocks.

Then, his brown labrador Oscar trotting alongside, he rode off himself to turn on 11 wind machines, mounted on towers around the 70-hectare property, that circulate the warmer inversion layer of air just above the treetops. "C'mon," he urged a baulky control, until the giant propeller 12 metres above roared to life. Through the frigid, moonless night, he roamed the rows of citrus, nervously reading thermometers and adjusting flaming heaters, as the pale pummelos glowed ghostly in the darkness.

Like many farmers, Smith lost his navel orange crop that week, but he escaped with minimal damage to the pummelos, which were somewhat protected by their thick rinds. This year's harvest looks to be first-rate, in both quality and quantity.

Pummelos with green rinds can be good, but best flavour develops when the skin begins to turn yellow. Peak season in the Central Valley runs from December to March or April; in the Southland, fruit ripens a month later, and many smaller growers sometimes let it hang into the summer. At market, look for heavy pummelos with a rich aroma. Medium-size fruits are best for eating; huge specimens, though much appreciated by Asians, tend to be dry and

woody. Aficionados maintain that pummelos stored for a month or more improve in flavour and juiciness.

To fillet a pummelo, slice off the top and bottom, and score the rind longitudinally, without cutting the flesh. Strip off the peels, saving them for candying, and remove as much as possible of the white pith. Tear the fruit ball in half, separate the segments, and use knife and fingers to remove the membranes.

Asians usually eat pummelos fresh, often with dips of salt, sugar and chile, which bring out the flavour. Dry, "ricey" pummelos are used in salads with chile and fish sauce. Chinese also boil the rind and use it as a vegetable in stews with meat and fish, while Persians and Greeks make jam of the peel and juice.

A curious northern Indian recipe for pummelo achar calls for the rind to be dried in the sun, then put up in a jar with carom seeds, a digestive, and set up on the roof to cure.

"When I was young boy, my grandmother would give me a bit - it's sour and salty, so a little goes a long way - to cure nausea or heatstroke," said Suvir Saran, an Indian chef based in New York. "It starts out yellow and turns a rich chocolate brown. That's when it's really tasty-after 60, 70, 80 years."

Pummelo Varieties

• **Chandler**. Medium to large, round or flattened globe, smooth light yellow rind, flesh pink (though it's barely tinged in cooler areas, and can be red as hamburger in hot climates), firm but tender, moderately juicy, with a pleasantly sweet taste. Season starts late October in the Central Valley, as soon as fruit "cuts pink," peaks in January and February, and can extend into July in southern groves. Hybrid of an acidless pummelo, Siamese Sweet, and Siamese Pink; introduced 1961, by James Cameron and Robert Soost, University of California at Riverside citrus breeders. Dominates pummelo production in California, where it's the only real commercial variety. At its best, of very good quality, but many commercial fruits taste bland.

• **Cocktail grapefruit.** Varies from orange to grapefruit in size; rind greenish yellow; pulp deep yellow-orange, very sweet and juicy, but seedy. Hybrid of Siamese Sweet acidless pummelo and Frua mandarin, crossed at UC-Riverside in 1952. Never officially released, but about 20 years ago someone swiped a cutting, and the fruit is now grown commercially on a small scale in the Central Valley, and for farmers markets.

• **Melogold**. Medium to large roundish fruit, rind thicker than a grapefruit's; pulp straw yellow, firm and juicy, sweet when grown in warm climate. May have an astringent aftertaste early and late in season, which runs December to April. Hybrid of Siamese Sweet acidless pummelo and a white grapefruit, released by UC-Riverside 1986. Several hundred acres planted, but of declining commercial importance. Compared to sibling Oroblanco, larger, with a thinner rind, less sweet, tastes more like a pummelo.

• **Oroblanco**. Small to medium flattened globe, thick rind (fruit is often marketed while skin is green); at best, has very sweet, juicy pale yellow flesh, without grapefruit bitterness. Season November to April; fruit can hang much later, but loses balance and tastes flat late in season. Same parentage as Melogold, released 1980. Intended as a substitute in California for white grapefruit, which often fail to sweeten. At first most were exported to Japan, but Israeli growers pirated the variety, renamed it the Sweetie, and stole that market. California growers, forced to sell Oroblancos for cattle fodder, are razing groves.

• **Reinking**. Large, pear-shaped fruit, with a prominent neck; thick yellow rind; crisp yellow-white flesh with excellent flavour, though usually too late for the Chinese New Years' market. Developed by J.R. Furr in Indio. Now obsolete as a commercial variety.

• **Sarawak** (aka Tahitian, Moanalua). Large round fruit, thin rind yellowish-green to yellow, flesh greenish-white, tender like a grapefruit, juicy with an exquisite lime flavour. Grown in Tahiti and Hawaii. In California, mostly found in backyards; one grower, Ignacio Sanchez, sells two acres of Sarawaks at farmers markets, but lost last season's crop in a freak April freeze.

• **Shaddock**. Another name for pummelo; from Captain Chaddock, who brought the fruit to the West Indies in the mid-17th century.

Using Pummelos

Pummelos vary in eating quality, depending on season and growing area. Fruits with green rinds can be good, but best flavour develops when the skin begins to turn yellow. Peak season in the Central Valley runs from December to March or April; in the Southland, fruit ripens a month later, and many smaller growers sometimes let it hang into the summer. At market, look for heavy pummelos with a rich aroma. Medium-size fruits are best for eating; huge specimens, though much appreciated by Asians, tend to be dry and woody.

Aficionados maintain that pummelos stored for a month or more improve in flavour and juiciness. Pummelos aren't suited to being cut in half and eaten with a spoon, like grapefruit, because the pulp doesn't come out easily that way. Instead, fillet a pummelo by slicing off the top and bottom as near as possible to the flesh and scoring the rind longitudinally, around the equator without cutting into the flesh. Strip off the peels, saving them for candying, and remove as much as possible of the bitter white pith. Tear the fruit ball in half, separate the segments and use knife and fingers to remove the membranes.

For an attractive presentation, arrange the segments in a circular pattern on a plate or use them in fruit salads. Asians usually eat pummelos fresh, often with dips of salt, sugar and chile, which bring out the flavour. Dry, "ricey" pummelos are used in salads with chile and fish sauce. Chinese cooks also boil the rind and use it as a vegetable in stews with meat and fish, and Persians and Greeks make jam of the peel and juice.

POT-IN-POT CULTURE

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There has been dramatic increase in interest in pot-in-pot (PIP) production and installation in Oregon and elsewhere. This article will present some of the common elements of above-ground and PIP production and aspects of PIP production in detail.

In the past 10 - 15 years, a change in consumer preference has resulted in a need for more container production. Virtually all varieties and types of herbaceous and woody perennials that can be produced in Oregon can be grown in containers.

Recently in Oregon, the production of deciduous trees and larger shrub materials in PIP culture has joined the container production rage. In the PIP production system, a planted container is placed in a holder pot that has been permanently placed in the ground.

PIP was first started in the southern states to protect roots from extreme summer temperatures, but really caught on in northern states because of the advantages in winter protection. Bailey Nurseries in Minnesota just recently expanded their PIP growing area by putting in 100,000 permanent pots this spring. Bailey's grows predominantly 5, 7, 10 and 15- gallon PIP materials, however, they also produce some 25-gallon materials and will be trying some 45s this year.

Potential

Growing trees and shrubs in above ground containers and PIP offers a number of production and marketing advantages compared with growing plants in the field (Ruter 1997). Listed below are some of these advantages.

Plants grown in containers can be sold from spring through to fall, whereas bareroot stock has a very narrow window of marketability. The prime biological advantage of container stock over bareroot is the root system is packaged and protected from stress. Containerized trees and shrubs, therefore, are more resistant to poor handling practices in the field and suffer less root disturbance and transplant shock (Davidson et al. 1988). Container production versus bareroot also allows the nursery manager to grow three to eight times more plants per unit area, depending upon the crop, reducing the need for expensive and productive field soils. The container producer can produce more plants in a shorter period of time and increase mechanization, resulting in reduced costs and higher returns.

Above ground container production, however, does have its drawbacks (Ruter 1997). Root hardiness during overwintering of container-grown nursery crops has become the most important factor limiting container production. Plants overwintered in containers suffer greater winter injury than those in the ground because the roots are surrounded by cold, circulating air rather than the relatively warm, insulating environment of the soil. The shoots also are more susceptible to injury from desiccation because the root zone is frozen in the

Shade trees in a pot-in-pot production system at Pacifc Nursery, Dayton, Oregon, United States. This new growing system combines the benefits of field production and container production. It originated in the southeastern United States and is becoming popular with growers throughout the country's nursery industry for growing shade trees and larger shrubs.

container.

Common winter injury problems found in poorly overwintered container stock are bark splitting, root kill, top kill, collar injury and desiccation injury. Two other problems with above ground containerized plants are windthrow and root kill, primarily on the south side of the pot, during hot summer days. PIP production does not suffer from the disadvantages listed above. PIP, however, has some disadvantages of its own that will be discussed later in this article.

Advantages of PIP

The PIP production system is an alternative to growing trees and shrubs in the field or in above ground containers. The PIP system can eliminate many of the difficulties associated with conventional container growing. In conventional container production winter protection for plant roots is costly and time-consuming. Wind tipping of containerized plants is another time-consuming, laborious, drawback of conventional container culture. Wind tipping is also detrimental to quality stock production as top-dressed fertilizers and media are knocked out of the pot and irrigation applications can be missed or delayed resulting in drought stressed trees. PIP production also eliminates the heat stress and root killing temperatures experienced in conventional container culture.

The PIP system can also eliminate many of the problems associated with conventional field stock production. In conventional field production, a tremendous amount of soil is lost or 'mined' during harvesting of B&B stock (Davidson et al. 1988). Conventional nursery field production also results in more soil compaction than in any other type of farming

(Bremer 1993). In this article we will discuss how PIP production has addressed some of these conventional production difficulties and problems and some of the pitfalls of the PIP system.

Growing Media

In both above ground and PIP production, the choice of container medium is of primary importance (Davidson et al. 1988). Adequate aeration in the container media cannot be overemphasized. Water-holding ability is also important but is a secondary factor compared to aeration. Since roots require adequate oxygen to grow properly, a poorly aerated mix will restrict root growth.

Total porosity of a mix is the amount of spaces between particles that could potentially be filled with either air or water. A value of 50% is adequate for total porosity. Aeration porosity is the amount of space in the mix filled with air after irrigation water has drained out. If aeration porosity is as low as 15%, the mix is poorly drained. Values above 30% are considered too high. Too much aeration is not bad, but it means that frequent irrigation will be necessary. A mix with a high percentage of very fine particles (i.e. <0.5 mm) results in low aeration porosity and poor drainage (Ontario Ministry of Agriculture & Food 1992).

Peat is a traditional mix ingredient in container mixes. Combining peat with equal parts of concrete grade sand is common in the Prairie Provinces and Midwestern states. Bailey's uses a mix of 1 part sand, 1 part peat, 6 parts wood chips and 1 part soil in their PIP operation. This is a heavier mix than they use in their above ground container production.

When using sand, alkalinity must be watched, especially when high pH sand is used and aeration is somewhat low. Bark is a common mix ingredient, throughout the US and Canada. It provides good aeration when mixed with peat. Coarse sawdust that is well decomposed is also useful as a mix ingredient. Fresh sawdust should be avoided because of its very high carbon/nitrogen (C/N) ratio. The CIN ratio of sawdust is 1000/1, of conifer bark 300/1, and for hardwood bark 150/1. To compensate for the high CIN ratio and to enhance decomposition, add approximately 1 kg of actual N (e.g. ammonium nitrate) per cubic metre of bark. Hardwood bark will decompose more quickly than conifer bark (Ontario Ministry of Agriculture & Food 1992).

A standard above ground container mix in British Columbia is 3 parts sawdust to 1 part peat. In Ontario, Canada, mixes such as 2 parts bark and 1 part peat, or 2 parts bark and 1 part sand, provide adequate aeration and water-holding capacity. Bailey Nurseries in Minnesota use a mix of 5 parts sphagnum peat (pH 4.0), 2 parts topsoil and 1 part woodchips for most deciduous above-ground container shrub production.

In the prairie provinces of Canada two common mixes are: 1) 55% sawdust, 30% peat, 15% sand; and 2) 34% sand, 33% soil, 33% wood chips. A standard mix in Oregon is 9 parts bark and 1 part peat.

Fertilizers

Plants produced in above ground containers and PIP require the same essential elements as plants produced in field culture. The total supply of minerals available for plant growth is limited by the size of the container (Johnson 1979).

Shrubs in smaller diameter pot-in-pot containers at Klupenger Nursery and Greenhouses Inc., Aurora, Oregon, United States. Pot-in-pot production is growing rapidly in the United States, most commonly among growers of shade, fruit and flowering trees, though the system is suitable for shrub production as well.

Good container media and nutrition management are basic to the production of quality container-grown plants (Hickleton and Cairns 1992). However, the decisions involved in providing good nutrition to container stock are complicated by a variety of factors: the multitude of fertilizer products available, the variations in container media, the number of species involved and the various cultural practices used (Swanson et al. 1989).

The impact of fertilizers on the environment and ground water is an important concern. To minimize environmental impact nursery growers are using controlled release fertilizers (CRFs). Some researchers have indicated that supplemental fertilizing with water soluble fertilizers, particularly nitrogen, is beneficial for fast growing crops when using CRFs. Soil tests are an important part of a container production operation. Potting mixes do not retain nutrients and the quantity of water applied causes rapid leaching. Biweekly sampling is suggested. Once the grower becomes familiar with test results, pH and salt readings may be sufficient information at each sample time and nutrient analysis can be less frequent.

Impact on Drought Stress

PIP systems generally use drip irrigation with in-line emitters. Designs vary in delivery rates; however, 2.3 litres/hour has been used with success. Because the root systems of PIP plants were contained, trees grown in the PIP system required less water than plants grown in conventional field culture (Chong and Mathers 1990). Irrigation was applied every two days

to PIP plants for four hours at a time (Chong and Mathers 1990). Field grown trees required watering eight hours.

Ruter evaluated cyclic irrigation on water use and found cyclic irrigation reduced the amount of water leached through the container in the PIP system by approximately 100 percent (Ruter 1997b). The combination of soil insulation and trickle irrigation ensure the essential moisture levels are maintained, eliminating the effects of drought stress that may occur in conventional container culture or even field situations. The soil insulation also results in more root mass in PIP produced plants (Ruter 1995). Therefore, PIP plants are better adapted to avoid drought stress in the nursery and after out-planting than conventional container grown plants.

Ruter notes that reducing the amount of water leached through the planted container is also important, since good drainage away from the holder pot is essential to the success of PIP. Sandy soils are well suited for PIP production. Growers need to take precautions if their sites have heavy soils that drain poorly (Ruter 1997b).

Impact on Heat Stress

The importance of keeping container substrate temperatures below 38°C is well documented; however, substrate temperatures in above ground containers in Oregon have been measured above 49°C. In Florida and other southern states, temperatures as high as 58°C have been recorded (Martin and Ingram 1988, Ruter 1997a). Normal root functioning ceases when root zone temperatures exceed 36°C for holly (Ruter and Ingram 1992) and at even lower temperatures, approximately 32°C, for less heat tolerant plants (Levitt 1979).

In above ground containers, the roots in the western quadrant of the container are often injured or killed by the high temperatures experienced. In the PIP system, roots in the western quadrant were 13°C cooler than in above ground pots (Ruter 1997b). Recently Fuchigami and Cheng (1999) have emphasized the importance of the plants' ability to photosynthesize and maintain optimum chlorophyll levels to ensure optimum growth and plant health. Plants that experienced high root-zone temperatures suffered loss of chlorophyll and protein production in shoots (Kuroyanagi and Paulsen 1988). Research indicates this has a significant impact on the overall plant health (Ruter and Ingram 1992).

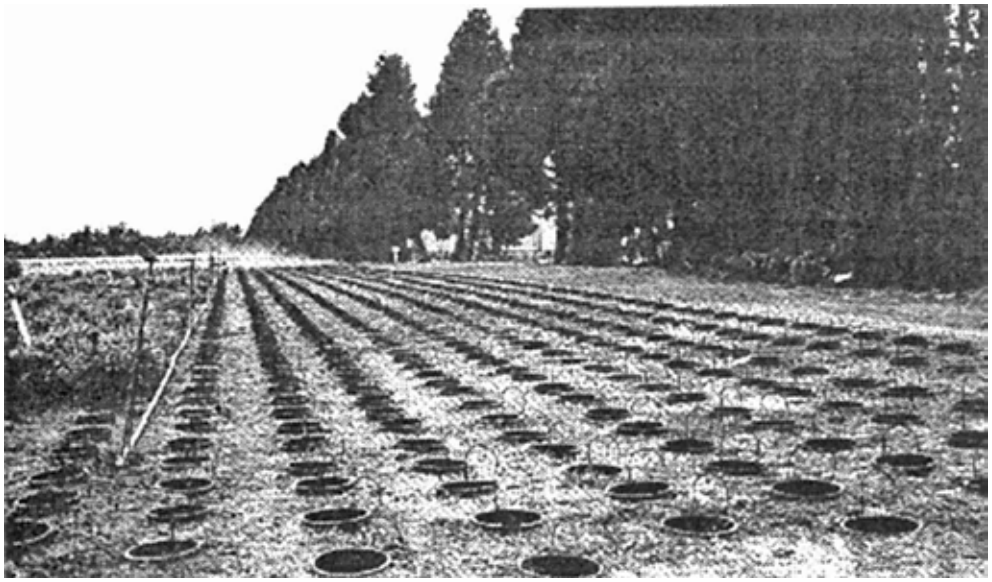
Impact on Soil 'Mining'

It is estimated that the harvesting of balled-and-burlapped (B&B) stock can result in the loss of 1175 tonnes of soil per hectare during being lost in the removal of a hectare of 112-cm diameter B&B trees. This is an average of 235 t/ha per year for a 5-year rotation (Davidson et al. 1988) or 7 cm in 5 years. Soil removal due to 'mining' has enormous implications to the economic viability of a field nursery (Murray 1993).

PIP is one management practice that can be used to reduce soil mining. Of course PIP requires relatively permanent modifications to a nursery field that result in soil profile changes. If for some reason you reverted a field from PIP back to conventional culture, however, the soil levels would be virtually unchanged.

Impact on Soil Compaction

Performing intense field activities during late fall and early spring, when rainfall is most frequent and soils are wet, results in soil compaction and reduced soil porosity (Bremer 1993).



Pot-in-pot Rhododendron production at Klupenger Nursery & Greenhouses Inc., Aurora, Oregon, United States. Holes are drilled into the ground and fitted with permanent plastic pots (sockets). Containerised plants are inserted into the sockets, and a drip irrigation spray head is staked into each pot.

The overall effects of conventional nursery field culture result in the reduction of the soil's productive potential and increased cost of production. Cover cropping reduces compaction by reducing the frequency of use of heavy equipment through 'minimum tillage' and by providing support to heavy equipment during wet weather. Compaction of nursery soils is much more harmful than growers realize (Trouse 1986). Using PIP, compaction is minimized due to reduced need for heavy equipment to lift the stock. Compaction in the root zone is nil because of the use of artificial media.

Overcoming Rooting Out

One of the problems with PIP has been the rooting out of the plant from the planted container, through the holder pot into the surrounding soil. Rooting out results in plants having to be manually dug and root-pruned before the planted container can be removed from the holder pot (Ruter 1997a). Various products have been tested for their ability to prevent rooting out. Products such as Biobarrier (a geotextile fabric impregnated with the herbicide trifluralin), Root Control (a fabric bag material placed between the planted container and the holder pot), and various applications of Spin Out (a commercial formulation of copper hydroxide) painted onto the side walls of the holder pot, painted onto the side walls of the planted container pot, painted on both containers, and applied to the planted container and Root Control fabric (Ruter 1997b and Ruter 1994).

Treatments which resulted in water pruning (Pellet 1983), air pruning (Chong and Mathers 1990), turning the containers 180° biweekly (Swanson et al. 1992) and other chemical barriers such as oxadiazon and pendimethalin have also been tested. Other fabrics have been

tested including Weed-X and Remay Typar '3-ounce' landscape fabric (Ruter 1997b), and Environmentally Friendly Containers, which have raised drainage holes on the sides (Ruter 1997b).

John Ruter has done most of the work in prevention of rooting out. He concluded in 1994 that Biobarrier was the best treatment for control of rooting out, but it also reduced plant growth. He stated (1997b) that Spin Out has been useful for reducing rooting-out problems but does not eliminate the problem (1997b). The physical controls, such as Environmentally Friendly Containers, water pruning, and air pruning, have had limited success with vigorous rooting species (Ruter 1997b). The 1800 biweekly turning of containers has been proven prohibitive due to labour costs (Swanson personal communication 1993).

Ruter has been continuing his rooting-out studies since 1994, looking at the rate of Biobarrier able to reduce rooting out in vigorous-rooted species but not cause phytotoxicity. Recently he has been conducting trials with Spin-Out treated fabric bags such as Tex-R Agroliners. He concluded in 1997 that the Tex-R Agroliners do a good job of preventing rooting out of some vigorous rooting plants, and that the bags were easily removed from the root ball, since the roots were not growing through the fabric (Ruter 1997b and Ruter 1998). The Agroliners are used as a bag-in-pot-in-pot production system.

Conclusions

The literature regarding container production indicates that the choice of container size (Fries 1977), planting mix (Lumis 1975; Spomer 1980) and fertilizer regime (Swanson et al. 1989; Johnson 1979; Brix and Van den Driessche 1974; Hickelton and Cairns 1992) has significant effects on the growth and quality of stock produced (Davidson et al. 1988). Container culture is a rapid growing segment of the nursery industry. Greater fundamental knowledge of the physiology of root hardiness in terms of heat and cold is required.

A large-diameter socket for shade tree production at Pacific Nursery, Dayton, Oregon, United States. Tree growers in the US. Pacific Northwest are installing pot-in-pot production systems by the hectare. Initially expensive to install, this production system offers many benefits over field planting and is proving cheaper to manage in the long run.

Greater knowledge of the basic plant processes accounting for the differential hardiness between roots and shoots could lead to development of methods to increase root system hardiness. A greater understanding of the water balance between the container soil, plant, and the interior atmosphere is necessary to explain and overcome desiccation problems. Evaluation of container mediums, fertilizer regimes, new overwintering systems and approaches are still needed. With research, further expansion and adoption of above ground and PIP culture will continue to rise.

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THE NUT SITUATION AND OUTLOOK IN TURKEY

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Introduction

Turkey is one of the major nut producing countries in the world. It produces around 73% of hazelnut, 13% of walnut, 18% of chestnut, 4% of almond and 14% of pistachio production of the world (Koksal et al, 1995).

Hazelnut has the largest share of nut production and increased its share from 56.9% to 61.5% in 1980-94 period. Walnut, having second place in total nut production, lost share from 23.5% to 15.9% in this period. Chestnut and almond took third and fourth place with 10.8% and 6.4% respectively and their shares remained almost the same. Pistachio, with the smallest share, has increased this from 2.9% to 5.4%.

Nut yields per tree (except for walnut) have increased in the last 15 years. Hazelnut productivity increased from 1.1 kg/tree to 1.4 kg/tree, while walnut productivity decreased in the 1980-94 period from 37.9 kg/tree to 34.5 kg/tree. Chestnut and almond yields increased from 36.7 and 8.9 kg/tree to 40.2 and 12.1 kg/tree respectively. Pistachio productivity also has increased from 0.9 kg/tree to 2.2 kg/tree in the same period.

Since the prices are like communication signals which serve in various ways to coordinate production and marketing decisions and the prices are also reliable data to work with, it is sensible to look at the prices received by farmers in the nut sector. There is a continuous increase in all nut prices with some exceptions. Prices of hazelnut, walnut, chestnut, almond and pistachio increased from $83.9, $94.6, $55.2, $76.3 and $225.3 per 100 kg in the beginning of the 1980s to $173.9, $129.1, $134.1, $102.4 and $277.5 per 100 kg in 1996 respectively. The trends in the prices indicate that substantial production increase in nut market might be expected in the near future.

Turkey is the leading country in hazelnut production, export and domestic consumption with 72.4%, 84.4% and 38.7 % respectively among the major hazelnut producing countries - the others being Italy, USA, Spain and Greece - according to 1990-95 average figures. Turkey is one of the oldest walnut producing countries due to being the motherland of walnut (Sen, 1986).

Although production of pistachio in Turkey goes back to very ancient times, today's production has not increased to the expected levels because pistachio is produced in dry and low productivity lands and thus yield per tree is very low. Pistachio production in Turkey is expected to enter into a new stage because of the Southeast Anatolia Project (GAP) which provided irrigated conditions for pistachio cultivation. Because of this large project, increases in pistachio production are expected in the near future.

Production

Hazelnut production increased from 286.7 to 481.7 thousand tonnes, while walnut production declined slightly with fluctuations from 121.3 to 118.3 thousand tonnes in the 1980-94 period (Table 1). Production of chestnut has continuously and substantially increased from 57.5 to 80.3 thousand tonnes with some fluctuations in the last 15 years. Almond production increased from 34.0 to 47.3 thousand tonnes in the same years. Pistachio production almost remained the same in the 1980s but increased from 13.8 to 39.8 in the 1990s and to 60.0 thousand tonnes in 1996.

Hazelnut, which is produced generally on steeply sloping land in the Eastern Black Sea Region of Turkey, and which has an important role in Turkey's economy, is one of the most important traditional export products. Hazelnut cultivation, which has the best ecological conditions in the Black Sea Region and protects land from erosion, is the most important economic activity in the region. Black Sea Region holds 68.9% of hazelnut production followed by West Anatolia (Aegean and Marmara Agricultural Regions) with 17.4% and Central Anatolia (Central North, Central East and Central South Agricultural Regions) with 12.6%. There was about 3.0% shift of hazelnut production share from Black Sea to West Anatolia Region in the 1980-94 period.

Walnut production is spread out all over the country. Central Anatolia Region holds the first place with 30.7%, followed by West Anatolia with 24.4%. Share of walnut production in Central Anatolia and Black Sea Region declined from 32.8% and 20.1% to 30.7% and 15.0% respectively in the 1980-94 period. On the other hand, share of walnut production in West Anatolia, Mediterranean and East Anatolia (North East and South East Agricultural Regions) regions increased from 21.8%, 6.7% and 18.6% to 24.4%, 9.0% and 20.9% respectively in

the 1980-94 period, with some fluctuations.

Chestnut is mainly produced in West Anatolia and Black Sea regions with 67.6% and 27.7% respectively and the remaining 4.7% is produced in other regions. Share of chestnut production in West Anatolia Region increased from 44.6% to 67.6% while share of chestnut production in Central Anatolia and Black Sea Regions decreased from 14.4% and 40.4% to 4.4% and 27.7% in 1980-94 period respectively with some fluctuations.

Almond is produced mainly in the West Anatolia and Central Anatolia Regions. Share of almond production in West Anatolia and East Anatolia Regions decreased from 39.4% and 20.7% to 32.5% and 12.0% in 1990-94 period respectively with some fluctuations while share of almond production in Central Anatolia and Mediterranean Regions increased from 27.4% and 11.4% to 34.1 % and 20.9% in 1980-94 period respectively.

Pistachio production is mainly concentrated in East Anatolia and Mediterranean Regions. East Anatolia holds 53.2% of pistachio production followed by Mediterranean and Central Anatolia Region with 36.9% and 11.3% respectively. East Anatolia and Central Anatolia Regions decreased their share from 53.2% and 15.7% to 47.7% and 11.3% respectively while Mediterranean and West Anatolia Regions increased their shares from 28.0% and 3.0% to 36.9% and 4.0% respectively with some fluctuations in the last 15 years.

International trade

Hazelnut export has an important place in Turkish economy and increased steadily from 104.2 to 184.3 thousand tonnes in the last 15 years (Table 2). Export of walnut is in small amounts and declined substantially from 2.9 to 0.4 thousand tonnes in recent years. From its production level, it can be said that walnut is being mainly produced for domestic consumption. Almond export was again in very small amount and declined from 0.5 to 0.3 thousand tonnes in the 1980-94 period. Almond is also produced mainly for domestic consumption. Pistachio export increased to 2.5 thousand tonnes in 1980s, decreased to 0.7 thousand tonnes in the beginning of 1990s and increased again to 1.25 thousand tonnes in 1996.

Pistachio growing in the Gaziantep region, Turkey

Table 1. Average nut production levels 1980-94 (1,000 t)

Period	Hazelnut	Walnut	Chestnut	Almond	Pistachio
1980-82	286.7	121.3	57.5	34.0	15.3
1983-85	325.0	115.4	57.0	37.3	13.6
1986-88	345.0	110.0	83.3	38.3	13.8
1989-91	470.0	116.7	78.0	46.0	39.3
1992-94	481.7	118.3	80.3	47.3	39.8

Source: SIS, Agricultural Structure and Production, 1980-94 and Black Sea Hazelnut Exporters Union Records.

Table 2. Average nut export levels (1,000 t), 1980-94

Period	Hazelnut	Walnut	Chestnut	Almond	Pistachio
1980-82	104.2	2.9	3.1	0.5	0.4
1983-85	131.2	2.5	6.1	0.5	2.6
1986-88	135.9	1.8	5.3	0.6	2.5
1989-91	164.9	1.2	4.4	0.3	1.5
1992-94	184.3	0.4	5.1	0.3	0.7

Source: SIS, Agricultural Structure and Production, 1980-94 and Black Sea Hazelnut Exporters Union Records.

Turkey exports hazelnut mainly to certain countries in four groups. Germany, the largest Turkish hazelnut importing country, increased its imports from 54.6 to 106.7 thousand tonnes with some fluctuations in the period of 1984-95. The other 7 largest hazelnut importing countries in Europe (Italy, France, Netherlands, Belgium, England, Switzerland and Austria) also increased Turkish hazelnut import from 44.8 to 98.4 thousand tonnes with some fluctuations. Russia decreased its Turkish hazelnut import from around 16.3 thousand tonnes to 1.7 thousand tonnes because of the breakdown of Russia in 1991. Other countries of the world increased amount of their Turkish hazelnut import from 5.5 to 34.6 thousand tonnes in the last 13 years.

Turkey is also exporting hazelnut to other hazelnut producing countries. Italy is the largest Turkish hazelnut importing country among hazelnut producing countries, followed by USA and Spain. Italy increased its Turkish hazelnut imports from 7.6 to 28.5 thousand tonnes in the 1983-95 period. USA, Spain and Greece also increased their Turkish hazelnut import from 1.5, 0.0 and 9.0 to 6.7, 5.7 and 3.1 thousand tonnes respectively in the same years.

Government involvement

Hazelnut producers usually sell their products under price level and payment conditions to the local merchants or to the Hazelnut Sales Cooperative (FISKOBIRLIK) of which they are members. This cooperative purchases hazelnut at a support price level which is determined for 1 kg unshelled hazelnut with 50 % yield. Hazelnut prices do not usually fluctuate below the market prices because of the purchases made by this cooperative and thus hazelnut producers do get a sufficient income (Sayili and Cicek,1996).

The support price level was $100.7 per 100 kg in the early 1980s, varied as $92.3, $112.6 and $99.3 in the 1980s, increased to $124.1 in the early 1990s and $187.5 in 1995-96, depending upon hazelnut market situations and political decisions. On the other hand, the export funding declined from $99.3 to $9.0 per 100 kg in the 1980-96 period. In conclusion, the government has supported hazelnut producers by increasing the support price, and hazelnut exporters by decreasing the export funding, which is a type of export tax on hazelnut exports, in this period.

The amount of hazelnut purchased by the Cooperative has declined from 152.9 to 83.7 thousand tonnes in the 1980-94 period with some fluctuations. On the other hand, the private sector has increased its share from 47.1 % to 81.3% in the last 15 years. This means that the share of the Cooperative in hazelnut market has declined. The amount of hazelnut exported by the cooperative declined from 40.7 to 4.7 thousand tonnes. But the private sector has increased its share in export from 60.7% to 97.5% in the last 15 years. These figures show that the Cooperative lost its importance in the foreign market more than in the domestic market.

Pistachio is purchased by the Southeast Agricultural Sale Cooperatives at support price level. In the high production years, these cooperatives enter into market to purchase pistachio at support price level in order to have prices not to go below a certain level which guarantees pistachio supply. After harvest, producers wait for the support price to be determined so that they can sell their products above this price level. This floor price stabilizes the market. Determining the support price level before the harvest might increase pistachio production and its quality.

Important issues

Hazelnut production increased in recent years along with marketing problems stemming from high levels of storage. Proposals such as restriction of hazelnut planted areas, increasing market share in domestic and foreign markets, and decreasing export funding levels for hazelnut have been put on the agenda. Cetiner (1988) claimed that hazelnut production should be restructured and the law fixing hazelnut planted areas should be enacted. Moreover, Aral (1990) said that there must be restrictions on hazelnut production and flat land on which hazelnuts are planted can be used for other agricultural activities. On the other hand, Koksal (1990) stated that hazelnut production must be increased but bottom lands should be spared for other crops. In Turkey, currently the problem is not an excess of supply but inadequate marketing.

Sagra and Ozalp (1988) suggested that increasing the domestic consumption level is a very important issue as far as the future of hazelnut is considered. Yucel (1990) also stated that increasing domestic demand for hazelnut production is important because there is a higher potential than today's consumption levels in the domestic market. To explore this potential, alternative consumption attitudes need to be created based on different price and income policies and taking the producer and consumer points of view into consideration.

Yucel (1990) stated that different kind of policies such as Hazelnut Support and Export Fund need to be implemented carefully by taking the conditions of producers and consumers into consideration. Ozesen (1988) suggested that export funding should be decreased or adjusted in necessary periods to avoid unjust competition. Pirincciogluand Arikbay (1987) discussed export funding level as dependent on hazelnut demand and supply, and concluded that increasing funding level slightly more than 100 cents per kg would be beneficial for the country.

Yucel (1990) said that although Turkey exports 70-75% of world trade of hazelnut, it does not have sufficient market power in the world hazelnut industry. Sagra and Ozalp (1988) stated that in foreign markets, there should be made an effort, not only for selling hazelnut but also for standardizing Turkish hazelnut, to give confidence to the customers by emphasizing marketing activities. Cetiner (1990) suggested that Turkey must try to expand hazelnut consumption in the world by creating new and different processed products containing hazelnut in their ingredients to create new markets to increase hazelnut export. Yazicioglu (1990) suggested that Turkey must also turn to new markets such as Japan and Russia, while maintaining classic European markets.

According to results of a Turkish hazelnut model constructed by Yavuz and Birinci (1996), reducing hazelnut planted areas causes its production, consumption and export to decrease. While lower hazelnut market price caused domestic consumption to increase substantially, higher per capita income made domestic consumption increase slightly. Supported hazelnut export negatively influenced foreign trade in hazelnut while affecting domestic consumption in positively. Increasing foreign demand for hazelnut caused export to increase and domestic consumption to decrease.

The economic problems that the pistachio market is facing are instability in price support and domestic and foreign marketing problems. The balance between production and export has not been reached yet. When there is production surplus and lack of export market, prices are low. In addition, when there is lack of production and excess foreign demand, prices become very high. There is a need to find stability in supporting price levels and foreign demand to improve pistachio production in quantity and quality. Since pistachio exporting is done in a traditional way, this process also needs to be modernized and better organized.

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THE PISTACHIO IN SYRIA

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Introduction

In Syria the pistachio tree has a notable place for many reasons, including:

- This tree is native to Syria;
- Syria contains a large genetic store in Syrian pistachio varieties;
- The country has a large store of wild *Pistacia terebinthus* plants, suitable for grafting to pistachio nuts;
- The pistachio may be grown on poor, rocky, and low-rainfall lands unsuitable for other trees or crops;
- It has economic value, with increasing demand for its products.

Syria has about 12 million pistachio trees over about 60,000 hectares, of which about 4 million are bearing. In 1996 these yielded about 23,000 tonnes of fresh nuts, in 1997 about 29,000 t.

According to FAO statistics, Syria comes fifth in world production of pistachio nuts. Production is centred in the northwest of the country, the main areas being those around Aleppo, Hamma, and Idleb, with Aleppo producing about 4 times and Hamma about 3 times as much as Idleb.

The following table shows area planted (ha), tree numbers (thousands), and production (tonnes) in 1997, according to statistics from the Syrian Ministry of Agriculture.

	--- Unirrigated---				--- Irrigated ---				
	Area	Trees	Bearing	Yields	Area	Trees	Bearing	Yields	Total
Aleppo	26004	4152	1798	12920	146	32	5	144	13064
Hamma	18305	2775	1235	8269	1674	277	149	2004	10273
Idleb	7193	1105	613	5448	177	27	24	453	5901

Pistachio flowering and production

The pistachio nut (*Pistacia vera* L.) is in the Anacardiaceae. The resinous, deciduous plants are dioecious (separate male and female plants). Bees are not attracted to the flowers. Female flowers are borne on wood of the previous year.

Plants are typically protoandrous, with male flowers opening some 10-15 days before female ones, which can give rise to pollination problems. These problems may be overcome by matching a suitable male pollinator variety to a female cultivar. In Syria, pistachio flowering starts in late April, which avoids spring frosts.

Growing conditions

Temperature

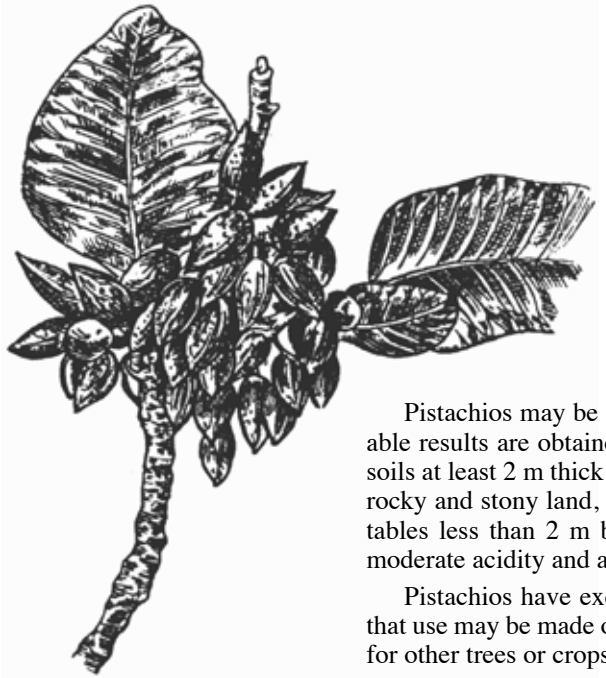
Pistachio cultivation in the northern hemisphere occurs in the 30-45° latitude range. The trees need low temperatures in winter and high ones in summer, with chilling requirements of at least 500-600 hours below 7°C for proper blooming and with high accumulated heat units for proper ripening of the fruits. Pistachios tolerate winter temperatures down to -32°C, and summer highs of up to 50°C.

Rainfall

The majority of Syrian pistachio plantings are unirrigated. Trees will survive with an annual rainfall of 250 mm, but 400 mm is needed for economic crops, and 500 mm is preferable. The distribution of falls over the period February to April can have a large effect on yields.

Air humidity

With their waxy leaves and thick bark, pistachios can take quite dry air. Humidity of 40% is needed for the flowering and fruit maturity periods.



Winds

With their flexible branches, pistachios can take strong winds, but hot winds can badly affect flowering and fruit ripening, causing flower drop and blank nuts.

Elevation

Pistachios prefer an elevation of 400-1000 m above sea level.

Soils

Pistachios may be grown many types of soil. Acceptable results are obtained in clayey, sandy, and calcareous soils at least 2 m thick. Pistachios will also grow on poor, rocky and stony land, but bearing will be delayed. Water tables less than 2 m below the surface are harmful, but moderate acidity and alkalinity to pH 8 are acceptable.

Pistachios have excellent salt tolerance, which means that use may be made of irrigation water which is too salty for other trees or crops, with salt content up to 4000-6000 ppm. The trees like limey soils (30 % calcium carbonate) and liming to this level is desirable, with tolerance of up to 80 % calcium carbonate.

Rootstocks

Possible rootstocks include *Pistacia atlantica, P. terebinthus, P. palaestina, P. lenticus, P. khinjuk,* and *P. vera*. The cultivars 'Ashoury' and 'Batoury' are used in propagation.

Pistachio cultivars in Syria

These include Ashoury (planted in the USA under the name Red Aleppo), Batoury, Red Oleimy, White Oleimy, White, Jalab, Nab El-Jamal, Lazwardy, Ain El-Tenah, Ajamy, Bundouky, and Marawhy.

Pistachio propagation

Pistachios are propagated in Syria from sowing seed, with the seedlings later grafted either in the nursery or in the orchard. Seed is sown during February-March, when the temperature is 15-18°C. Germination time is 15-55 days, or 45-60 days for *P. atlantica*. Seeds are sown in plastic bags with drainage holes, 20 cm across and 55 cm high, containing a sterilized soil mixture of clay, sand, and animal manure in the ratio 3: 1: 1.

Seeds are first floated in water to eliminate empty ones, soaked for 4-6 hours, then stratified in January in 10 cm deep wooden boxes filled with sand. Seeds which swell are removed from the germination box and planted 2-3 to the bag, 3 cm deep, with the seed opening facing up. Bags are watered with sprinklers as necessary and thinned to a single plant once this reaches 5 cm in height.

Seeds may also be planted directly every 5 cm and 5 cm deep in prepared nursery rows, 80-90 cm apart, and drip irrigation applied.

Grafting

Seedlings reaching a diameter of 6 cm are T-budded, 10 cm above ground level, in June. Most plants do not reach this diameter in the first year, and these are cut back to 5 cm above the ground in the winter, with budding taking place the next year on new growth.

Planting

After soil preparation, trees are planted in 70 x 80 cm holes, in rows 7-8 m apart in unirrigated orchards and at 6 x 6 spacings in irrigated ones. Planting is done between December and February, with a 15: 1 female:male ratio.

After planting

Irrigation to bring total water applied up to 500 mm/year is recommended, although increased irrigation can lead to bark canker caused by *Agrobacterium*.

Soil water holding is improved by cultivation, with a deep cultivation in the autumn before rains fall, followed by a shallow cultivation in spring and further surface cultivations once a month during summer.

Soil texture is improved by repeatedly adding animal manure or by sowing leguminous plants and turning them and weeds in at flowering time, before the end of the rainy season.

Trees are pruned each year, usually in winter, from their second to their sixth or seventh year. Pruning regimes vary to suit rootstock, cultivar, type and depth of soil, annual rainfall, planting distances, and winds.

Bearing trees after age 7 are required to be pruned each year by experts, with the aim of achieving balance between leaf and fruit growth.

Fertilizer

Animal manure improves soil texture and water-holding capacity. The recommendation is to add 15-20 kg of old manure to each tree every 2 or 3 years, before the autumn cultivation. Chemical fertilizers are advised in 250 mm or less rainfall zones at the following rates per tree: 2.5 kg N(21%), 3 kg P_2O_5 (18%), 1 kg K_2O (48%), 50 g zinc sulphate, 50 g manganese sulphate, and 100 g iron chelate.

Bearing, ripening, and picking

In a 400 mm rainfall zone, pistachios will start bearing between years 8 and 10, while at 250 mm, bearing is delayed till year 12. Under 500 mm rainfall or when irrigated, bearing will commence at years 5 or 6.

Nuts will start to mature in Syria between August 10 and the end of September, depending on the following factors.

- Cultivar. Ashoury is the earliest one, then Batoury, and then 'White'.
- Elevation. At higher elevations, ripening occurs later.
- Rainfall. Trees in drier zones ripen their fruit earlier.
- Cluster position. Nuts in a cluster do not all ripen at the same time. Those at the base ripen first and those at the top, last.

Picking is done manually. The nuts need to have the outside husk removed, followed by cleaning in a small machine (averaging 3 t/day). After this, nuts are soaked in a salt solution for 24 hours, dried in the sun for 8-10 days, then graded and packed in jute bags in three groups of 600, 860, and 965 graded nuts per kilo.

A 10-year-old tree produces about 10 kg of fresh nuts, at age 30 years yields reach 30-35 kg, and yields after that can advance to 50-100 kg, depending on rainfall and cultivation applied.

For more information about the pistachio in Syria (research, experience, seeds, grafted trees), do not hesitate to contact me (attention Mohammad Taher Maller) at PO Box 7831, Aleppo, Syria (phone +963-21-5712 710, fax +963-21-5712 252).

DEVELOPING THE NON-ASTRINGENT PERSIMMON INDUSTRY IN AUSTRALIA

-- RETROSPECT, PROSPECT AND LESSONS LEARNED

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Abstract

The persimmon, *Diospyros kaki* L., is a native of China with 2000 years of recorded history. Its fruit is widely consumed throughout Asia. Relatively recently, non-astringent cultivars became commercially available, presenting opportunities to southern hemisphere countries, such as Australia, to produce fruit for northern hemisphere consumption out of season. The Australian non-astringent persimmon industry is small but growing strongly. Starting from a close to zero base in the early 1980s, annual production may exceed 1000 tonnes in 1996.

Development of the industry has centred around a core group of growers and marketers who are committed to working together. In 1994 they incorporated to form the Australian Persimmon Export Company Pty. Ltd. (APEC), and by 1995 had established the number one brand in Singapore during Australia's export season. In 1996 they launched a second brand and exported about 50 000 trays, estimated to be more than half the Australian total exports.

In an emerging industry APEC demonstrates an unusually high level of professionalism, largely the result of developing cohesiveness and a sense of empowerment. Over the six years of the group's activities to date three major lessons have been learned. They are that new industries need reliable information, a marketing orientation, and a vehicle through which they can achieve collective vision. The approach taken to developing the non-astringent persimmon industry has been cited as offering valuable insights for other emerging primary industries in Australia.

Introduction

The persimmon, *Diospyros kaki* L., is a fruit crop of Chinese origin whose recorded history exceeds 2000 years (Pieniazek 1967). The fruit is widely consumed in the northern hemisphere, especially in China and Japan, but also in Europe and North America. Relatively recently, non-astringent cultivars became commercially available. Their fruit could be consumed free of astringency while still quite firm, unlike the fruit of astringent cultivars, which does not lose its astringency until it is very soft, and therefore does not tolerate the rigours of traditional marketing channels. This has presented opportunities to trade in non-

astringent persimmons between distant countries. As a result, southern hemisphere production of non-astringent persimmons has steadily expanded over the last twenty years, fuelled largely by counter seasonal marketing opportunities in northern hemisphere Asian markets.

Australia has been a part of this trend. Although its industry is still small, it is experiencing strong growth, and its development has been based on a model which is unusual for an emerging primary industry in this country. This model is founded on a core group of growers and marketers who are committed to joint action, and who between them represent more than half the industry. This group, drawn from five states and incorporated as a private company, is called the Australian Persimmon Export Company (APEC). Even in a small industry APEC has demonstrated significant collective impact, and the commercial performance of the group to date has been impressive. Other emerging industries, as well as the persimmon industry in New Zealand, have expressed interest in the approach APEC has taken.

This paper reveals that over the seven years of APEC's activities to date three major lessons have been learned. They are that new industries need reliable information, a marketing orientation, and a vehicle through which they can achieve collective vision. Before reaching these conclusions, the paper briefly reviews the history of the persimmon in Australia, then focuses on the development of APEC.

Retrospect - History and Background

Brief History of the Persimmon in Australia

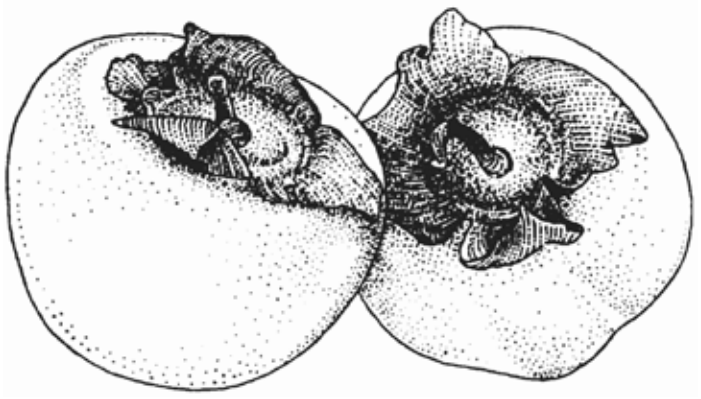
The earliest official record of the persimmon in Australia dates back to 1864, when fruiting trees were recorded in the collection of the botanic gardens in Brisbane (anon. 1864). Commercial production had started by the early 1900s in at least Queensland, New South Wales and Victoria. For example, wholesale prices for persimmons were quoted in the Brisbane wholesale markets in 1903 (anon. 1903), and by 1925 persimmon tree numbers in New South Wales totalled 24 000 (anon. 1925). Until 1967 only astringent cultivars were available in Australia. In that year, CSIRO at Merbein in Victoria imported Fuyu, the world's most important non-astringent cultivar (W. Lewis, Merbein Research Station, personal communication). Over the ensuing decade, other introductions were made, and Departments of Agriculture assembled collections of both astringent and non-astringent cultivars. Arguably the most significant was that of the Maroochy Research Station at Nambour in Queensland. This collection was established in 1976 and by 1982 totalled 250 trees of 50 cultivars (A. George, Maroochy Research Station, personal communication).

Significant commercial production of non-astringent persimmons began from an almost zero base in the late 1970s and has grown to a total production of around 500 tonnes from 150 000 trees (Australian Bureau of Statistics). About half the crop is exported, mainly to Singapore (Australian Bureau of Statistics). Approximately half the total exports are from APEC (Collins 1995).

Origins of the Australian Persimmon Export Company

APEC arose as a result of the first national persimmon industry workshop, held at Coffs Harbour in 1989. This workshop, funded by the Rural Industries Research and Development Corporation and the DPIE Marketing Skills Program, was aimed at bringing together

all the key players in the nonastringent persimmon industry - an emerging industry seen as having significant growth potential, especially in terms of developing exports to Asian markets (Collins 1989). As a result, 12 growers committed themselves to a thorough trial of the concept of joint export market development. These growers formed the core of what became APEC, now comprised of 30 growers from five states exporting two brands and commanding more than half Australia's persimmon exports (Collins 1995).



Performance of APEC

The performance of APEC can be assessed from a number of angles. Key measures of performance reported in this paper relate to group size and rate of growth, representativeness, export performance and level of empowerment. Each is discussed in turn.

Group size and rate of growth

As indicated above, the original group of twelve has grown steadily to about thirty over the last six years. Growth has been controlled in the sense that entry to the group is by agreement from existing shareholders. There is no automatic right of membership to any interested outside party.

The process of admitting a new member is generally that the person must be recommended or known by an existing shareholder, or if unknown to any of the shareholders, there will be some level of investigation to ascertain if they are the 'right' kind of shareholder for APEC. This investigation is done by one or more board members. It is intended to determine if the person is a professional fruit grower, if they have the intention of planting a substantial orchard of non-astringent persimmons (a minimum of at least 250 trees), and if they seem likely to be able to make a genuine commitment to the ideals of the company. Growers in the company explain this selection process as one which is designed to protect their six years of personal and financial investment in getting APEC to its present state. Occasional criticisms are made that APEC is an "exclusive club". Shareholders agree, but it is not a case of exclusivity without a commercial purpose.

Export performance can be measured in terms of market penetration. APEC exports have risen from 3 000 trays in its first season (1990/91) to around 50000 trays in each of the 1994/95 and 1995/96 seasons. More than 90 percent of fruit has gone to Singapore, where APEC's main brand "Sweet Gold" is recognised as the number one brand in the February to mid May period. Returns to APEC growers have, on average, exceeded both those of domestic mar-

kets and those of other exporters in the same markets.

The growers in APEC include Australia's two or three biggest. Total tree numbers controlled by group members is approaching 60 000, or about 40 percent of the estimated national total. More importantly, fruit exported from these trees now represents more than half the country's exports .

Representativeness

Export performance

Since its formation, APEC has contained a mixture of Australia's biggest growers of non-astringent persimmons, and some of its smaller but very dedicated growers. As indicated above, key criteria for membership were not aimed at size, but at quality - especially the quality of the people themselves as demonstrated by their commitment to the goals of the company. Presently, APEC is the industry's only commercially oriented grouping of stakeholders. It represents about 40 percent of total tree numbers, but more than half the total exports.

Exports by APEC have risen from 3 000 trays to almost 50 000 trays over the last six seasons. More than 90 percent of these have been consigned to Singapore, though in 1996 trial shipments were sent to Thailand and France. Other minor markets include Malaysia and Hong Kong. While exact returns to growers are commercial in confidence, they compare favourably with those which could have been achieved by selling on domestic markets, or selling through traditional exporters.

Another important indicator of the group's performance is its development of two brands, owned and internationally registered to APEC. The first, Sweet Gold, is its original brand for top quality export fruit. This brand was developed following focus groups with Singaporean consumers, and it is now recognised as the number one brand in the Singapore market during APEC's export season, February to May. The second brand, Golden Star, was developed in 1995. The purpose of developing a second brand was to accommodate another grade of export fruit, slightly below that of Sweet Gold. The concept is to allow penetration of different segments in existing markets, or access to other markets for which the Sweet Gold standards may be unnecessarily high. Trialling of Golden Star in 1996 produced promising results.

Level of empowerment

Empowerment is an important indicator of performance because it measures the degree to which groups or individuals accept responsibility for their own performance. In groups this has been shown to involve working as an effective team. Argyris and Schon (1974) define effectiveness as the ability to gather relevant data, make sound, free, and informed decisions, and implement these decisions with commitment. Wellins et al. (1991) suggest that when a group of people with a common goal reaches such a level of effectiveness, it can be called an empowered team. Empowered teams have been reported in manufacturing, service and white collar industries (Walton 1985; Semler 1989; Wellins et al. 1991), but there is nothing in the literature to describe their application in primary industries as a vehicle for strategic development.

Through the act of incorporation APEC took on a level of responsibility for its own actions. To this end, it created a board of five directors, one of whom is the executive director responsible for the day-to-day operations of the company. Directors must be drawn from at least three states. They meet face to face about four times a year, and through teleconferences at other times. Once a year the annual meeting of shareholders reviews company activities and holds elections for new board members.

So APEC takes responsibility in the legal and executive sense, but the other test of empowerment is whether or not the organisation is effective. The section on performance above indicates that APEC has achieved quite high levels of effectiveness in terms of developing export markets and returning attractive prices to its grower shareholders. It seems reasonable to conclude, therefore, that APEC is performing in accordance with Wellins' (1991) definition of an empowered team.

Prospect - the Future

APEC is an unusual example of a vehicle for the development of a new primary industry in Australia, and though successful to date, it has been in existence for a relatively short time. Any discussion of its performance must therefore also be forward-looking as far as that is possible in such a situation. This discussion about future influences on APEC centres around three issues. They are whether it can retain its competitive advantage in export markets, whether it can retain its shareholder members, and whether it can retain its present level of empowerment.

Retaining Competitive Advantage and Shareholders

All three issues identified in the paragraph above are linked, but especially the first two, which are the topic of this section. If APEC retains its competitive advantage, then it has the attractant for retaining members so long as the competitive advantage of the group is translated into individual advantage for members. This is most likely to take the form of better returns to members, though better returns are not the only form of individual advantage possible. Other forms include simplifying the export marketing process for its members, providing additional services such as training in quality management or information about production systems, or providing a forum through which members' concerns can be addressed.

Informed speculation about the future of APEC in this regard would indicate that it is likely to retain competitive advantage in its major market, Singapore, because there are no signs of other groups emerging, and its Sweet Gold brand is already well established and commanding a price premium which is being passed on to members. Other markets will continue to be developed, as will the company's Golden Star brand. In addition, services such as training in quality management and the provision of cultural advice will continue to be part of ensuring growers know how to grow and present product of a quality which matches market demands.

It is almost certain that APEC will continue to expand until all 50 shareholder places allowed by the law under which it is incorporated have been filled. Presently there are another five applications from prospective shareholders being considered by the board. As previously indicated, quality rather than quantity of shareholders will be the key selection criterion.

Staying Empowered

The incentive for staying empowered will have its roots in a continuing satisfactory level of overall performance of the company. This is speculated on the grounds that empowerment comes at a personal cost, especially to board members, who commit considerable time and mental energy to the task of company management. The personal satisfaction of having created and managed this innovative company is no doubt a powerful motivator for its foundation members, but in the future the motivation for personal commitment to the ideals of APEC will more likely derive from the company's record of commercial performance. Thus empowerment is also linked to retaining competitive advantage. Given the likelihood of APEC continuing to retain this advantage, it also seems likely that an empowered membership will be a feature of APEC's future.

It may be useful to visualise the future shaping forces on an organisation such as APEC in an emerging primary industry as a three-way interaction between competitive ·advantage, retaining membership, and retaining empowerment, as illustrated in Figure 1.

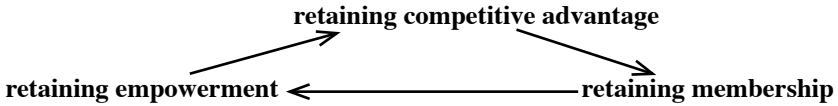


Figure 1. Shaping forces in emerging industry organisations

It would seem necessary that the primary objective be to retain competitive advantage. This facilitates the retention of membership, and these two together provide the base upon which empowerment can be maintained. Maintaining empowerment provides the intellectual energy which can be channelled into retaining competitive advantage.

Lessons Learned

APEC as a single case study cannot provide generalizable solutions to the many problems facing the emergence and development of new primary industries. However, through analysing its six years of evolution to date, it is possible to observe certain factors which have underpinned its success. Collins and Dunne (1996) identify two broad groups of factors related to the success of such groups. They are predisposing factors and process-related factors. Each is briefly discussed in this section in the context of APEC's development.

Predisposing Factors

Predisposing factors are those which characterised the environment in which the company emerged. Significant among them is the fact that group members were drawn from a wide geographic base. This not only extends the harvest period and spreads the risk of crop failure but it also means that group members probably have little history of regarding each other as competitors, such as would be the case if all members were from the same region. APEC members are drawn from all five mainland states, the two most widely separated growers being at Perth in Western Australia and Gladstone in Queensland. As there had been very little trade in the product before the group was formed, there was no history of group members in competition with each other.

A second predisposing factor is whether the group originally contained key people in the emerging industry. These may not be the biggest growers, but they will be growers with a high level of commitment to the new industry's development. They are often referred to as "champions" of the industry. Their role is to maintain enthusiasm, help in recruitment of new members, be spokespersons, and generally to create a positive environment in which collective decisions can be made. The original APEC core of about 12 growers were all key people and they each played a significant role in subsequent development of the group. Some were comfortable providing the 'public' face of the group, others worked behind the scenes marshalling resources and monitoring progress.

Finally, the group is predisposed to succeed when its members are prepared to embrace change. New industries by definition involve change, and a preparedness to challenge traditional ways of thinking can be a valuable asset in a group grappling with the vagaries of an emerging industry. In the case of APEC the whole concept was to focus the development of the emerging non-astringent persimmon industry on a core group whose goal was to create and manage its own export activities. This was the opposite of the traditional approach of 'letting the market sort out the players', and could only have been possible in a group capable of managing the discomfort of an uncertain environment.

Process Related Factors

Though groups may approach the opportunity to engage in industry development with all the right predisposing factors, Collins and Dunne (1996) argue that this in itself does not lead to success. They claim that the actual process of group building and engaging itself with the commercial world must also contain three factors related to success. They are the availability of reliable information, the adoption of a marketing orientation and the development of collective vision.

Reliable information underpins reliable decision making but new industries are characterised by lack of information. Thus it is especially important that the process of group building in a new industry be focused on acquiring the most reliable information possible. The development of APEC ran in parallel with a major University of Queensland Gatton R&D project which spanned pre-harvest, postharvest, marketing and food processing aspects of the Australian non-astringent persimmon industry. Along with specific marketing research underwritten by the group themselves, this provided the information base upon which development plans were laid. The author was both principal researcher of the R&D project and facilitator of APEC's development, providing a direct link to information as it became available.

Adopting a marketing orientation is a modern day catchcry of business success. It is commonly defined as an orientation of a business towards the consumers of its products as opposed to an orientation towards its production functions (Kotler 1980; McCarthy and Perrault 1984; Houston 1986). While the concept is deceptively simple, its application to primary production can be difficult. Farmers are well known for their focus on producing more and better, sometimes even when the market is signalling that it is already well supplied with product. In a new industry there are two opposing forces. One is the force to learn more about how to grow 'bigger and better'. The other is the force to learn more about the 'who, where, how and why' of the new product's consumption. The natural tendency for growers to focus on the former at the expense of the latter must be curbed. In the case of APEC, one way of doing this was to take growers to the export markets to see their product being sold.

Every year since 1990 between two and ten representatives of APEC have visited Singapore plus at least one other Asian market. The aim is to learn how the market works, and what the group needs to do to better satisfy its customers in the market. One secondary, though very important, benefit from this approach is that growers build relationships with importers and others in their target markets. The main benefit, however, has been a clear focus on the group's customers rather than on its production capability.

Collective vision implies a common view of the future. This, too, needs to be developed as part of the group-building process. While new crops typically present growers with many short term issues to be dealt with, they also require an eye for the future. In particular, establishing competitive advantage must be followed by the identification of ways to sustain this advantage. This demands the development of a strategy, which in turn demands that a collective view of the future be developed. Collective vision for APEC arose through workshops once or twice yearly at which progress to date was reviewed for the purpose of determining how future plans might be formulated. This process included the development of a vision statement and strategic plan. Early in the group's development, there was more focus on short term issues, but as market performance improved, confidence in the group's collective ability rose. The process began to build on itself. More confidence in ability resulted in more confidence in the future, and this led quite naturally to the development of collective vision.

Summary of Lessons Learned

From the discussion above, lessons learned can be summarised.

Lessons learned - Predisposing factors

Lesson 1: Members drawn from a wide geographic base are more likely to co-operate rather than compete.

Lesson 2: The initial group must contain key players who can champion the cause of the emerging industry.

Lesson 3: There must be a willingness to embrace change among group members.

Lessons learned - Process-related factors

Lesson 1: The group must identify ways to determine the reliability of information upon which it is basing its decisions.

Lesson 2: A marketing orientation, rather than a production orientation, must be developed.

Lesson 3: To sustain its competitive advantage, the group must develop a sense of collective vision.

Conclusions

This case study of the Australian non-astringent persimmon industry illustrates that it is possible for a new industry to develop with strategic purpose at the same time as being commercially successful. But the process has required a level of management not usually found in emerging industries, which are more typically left to themselves until either serious problems begin to appear, or until they have already shown commercial promise. Early intervention seems to have been a key ingredient in the success of APEC.

Along the way, the lessons learned may provide valuable insights for other developing industries, but they are certainly no recipe. Industries, particularly new ones, are idiosyncratic. Each has characteristics which dictate that approaches to its development need to be tailored to the specific needs of its producers, marketers and consumers. On the other hand, lessons learned from the development of a new industry such as those reported here for the Australian non-astringent persimmon industry have not previously been published. For the time being, at least, these lessons may provide the most valuable starting point for those interested in some form of strategic intervention in the new industry development process in agriculture.

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THE BUTTERNUT AND THE BUARTNUT

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Introduction

The butternut (also called the oil nut or white walnut) (*Juglans cinerea*) is a member of the walnut family native to North America, where its large edible nuts have been long relished. It is the hardiest member of the walnut family, with a range which extends well into Canada. It is considered by some as the best of all nuts, but it remains little known in most parts of the world.

Description

Butternuts can reach 30m high in American forests, but are more usually spreading-topped medium size trees (18 m) with a straight trunk which can reach 60-100 cm in diameter.

The bark is lighter, greyer and smoother than that of black walnut (*J. nigra*).

All the young twigs, petioles, leaves, buds, and fruit are covered with a fine hairy down which exudes a sticky substance.

Leaves are 35-60 cm long, compound with 11-19 leaflets, each serrated and pointed (much like the black walnut). Leaflets are 5-12 cm long and up to 5 cm wide, yellowish-green and turning yellow or brown before failing in the early autumn.

Like other walnuts, the male flower is a catkin, light yellowish-green, 1-10 cm long; the female flowers are borne in clusters from leaf axils, each with two stigmas which open to reveal a striking red surface. Flowering usually occurs in May or June, and the male and female flowers, though borne on the same tree, usually mature at different times, hence single trees crop poorly. Cross pollination occurs with all other members of the walnut family.

The nut is light brown, pointed and oblong with 8 very deep rough, sharp ridges running lengthwise along the shell. The kernel, white to cream in colour, is thin and difficult to removed without extensively cracking the shell.

The nuts are enclosed in a thick sticky hairy husk, and are borne in clusters of 2-5. Each fruit is 3-6 cm or more in length by 25 mm or more in diameter. The shell, though hard, can generally be broken without difficulty (as many of the cultivars have thinner shells) and the kernel easily separated. On wild trees, the shell cracks only after a considerable blow.

Fruits usually ripen in October, and seedling trees start bearing at a fairly young age (5- 8 years from planting).

§ Member, WANATCA

The butternut is native to the Eastern parts of the USA (south to Georgia and West to the Dakotas and Arkansas) and Canada (New Brunswick to Manitoba). Some selections are known to be hardy to zone 3 (-35°C), though most can be assumed to be hardy to zone 4 (-25 to 30°C). It lives to a lesser age than many walnuts - 80-90 years.

Buartnuts (butternut-heartnut hybrids) are vigorous trees of similar habit and uses.

Native range of buartnut

Uses

The nuts are sweet, very oily and fragrant, with a rich agreeable buttery flavour. They are eaten fresh, roasted or salted; for flavouring; and are particularly popular used in cooking (pastries) and in confectionery manufacture (like black walnuts, *Juglans nigra*). One traditional use in New England was in combination with maple sugar in making maple-butternut candy.

Kernels form roughly 20% of the weight of the total nut. They contain, on average, per 100 g: 25 g protein (very high), 64 g fat, 8.7 g carbohydrate, 7.1 mg iron.

Young butternuts are sometimes pickled like green walnuts after being rubbed smooth. They are harvested in early summer (when a pin can still be thrust through the nut without any marked resistance), soaked in a mild brine for 3 weeks, then scalded and the outer skin rubbed off; the nuts are then covered with a 'syrup' of water, vinegar, sugar and spices.

The oil pressed from nuts can be used as a cooking oil. The sap can be tapped and made into a syrup much like maple syrup.

The inner bark (usually of the roots) is used medicinally, containing juglone, juglandin and juglandic acid. It is alterative, cathartic, laxative, rubefacient, stimulant, tonic and vermifuge; traditionally used for cancer, dysentery, epithelioma, fevers, liver ailments, mycosis, tapeworms, and warts.

The sticky substance exuded from the downy covering contains a well-known dye. The green nuts and bark were widely used as a dye source - they are boiled to produce yellowish orange (nuts) and brown (bark) dyes, which were widely used 200 years ago ('butternut jeans' became a sort of uniform for many Confederate soldiers in the Civil War).

The wood from butternut is highly prized, being satiny, warm-coloured, warpless and enduring. The heartwood is medium dark chestnut-brown, but not as dark as black walnut which it otherwise resembles. It is straight grained with a coarse but soft texture, moderately strong and heavy, and weighs about 450 kg/m3. It is easily worked with both hand and power tools and there is little resistance to cutting edges. The wood nails, screws and glues well and

can be stained and brought to an excellent finish. It is not durable outdoors and is moderately resistant to preservative treatment.

It is a favourite of wood carvers and interior decorators, used for high class joinery, interior trim for boats, superstructures, cabinet fitments, furniture, boxes and crates. It is sliced as a decorative veneer and used in place of black walnut for furniture and wood panelling. It makes a good fuel wood. Apart from North America, it is cultivated as a timber tree in Denmark and Romania.

Cultivation

Like other walnuts, the butternut likes a deep, fertile, well-drained and moist soil, preferably slightly acid or neutral; and a position in full sun. Limestone soils are tolerated. Where native, rainfall varies from 540-1230 mm per year and annual temperature from 8.4 to 18.0°C, with cold winters and hot summers, i.e. a continental climate. It is often found on river bottoms and tolerates a high water table.

Although very winter hardy, the tree is less hardy in mild temperate regions like the UK, because the cooler summers do not properly ripen the new growth, which is then susceptible to late spring frost damage. The tree has never been noted as a good cropper in the UK, but this may largely be due to ornamental plantings of a single seedling tree - never likely to crop well in any climate. Cultivation has been successful in British Columbia, so with good selection of cultivars there is potential as a cropping tree in Britain.

For nut production, trees should be planted at 8-12 m apart; for timber production, a much closer spacing of about 5 m is appropriate. Trees produce a deep taproot and are best transplanted as young plants - older plants may take a year or two to recover. At least two cultivars or seedlings from different parents should be grown to ensure cross pollination. Trees can be expected to grow about 3 m in 10 years in British conditions, rather more in a warmer climate.

A substance which is toxic to some plants, Juglone, occurs in roots and is washed into the soil from decaying leaves (it is not present in living leaves). Juglone is quickly detoxified by the soil, but in some circumstances and soils it may rise to concentrations which are detrimental to apples in particular, also to Ericaceae, *Potentilla* sp, *Pinus strobus* and *P. resinosa*, potatoes and tomatoes, and French beans. These species should be avoided in planting schemes.

Seedling butternut stock inherit the leafing characteristics of their parents, hence for late leafing seedlings, seeds from a late leafing cultivar like

Creighton should be used if possible.

Several cultivars are known to have good timber form, and seedlings from these are much more likely to be useful timber trees than random seed from unknown trees.

Harvesting and yields

Grafted trees take 3-6 years to start bearing; seedling trees usually take about 6-8 years. Yields are smaller than those of walnuts, perhaps 30-50 % at most (i.e. around 14-23 kg of in-shell nuts) .

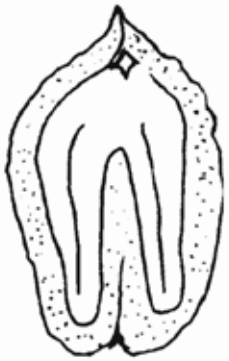
Nuts are harvested after they drop by picking up from the ground. The fruits can also be knocked off the tree when ripe (they turn from greenish-bronze to greenish-brown when ripe).

The husks are gummy and result in gummy hands and gloves. Any husks still attached must be removed - this requires some effort with butternut, as the shells have 15-20 linear spiny ridges projecting into the husks; American growers recommend throwing them in a concrete mixer with some chunks of concrete! Leather gloves should be worn to protect fingers from these sharp ridges when removing the dried husks with a knife and/or brush. They are easiest to remove when at an early stage of ripeness (still soft).

The nuts should be allowed to dry for a few weeks by spreading them in a warm airy room, stirring occasionally. They should be stored in a well-ventilated, dry, cool, mouse and rodentproof place.

Kernels are removed by cracking nuts: a heavy duty nutcracker is usually required (e.g.. an American version made for black walnuts); a hammer and anvil or block of hard wood is good; alternatively, nuts can be covered with hot water, soaked until the water cools then they will crack easily. The kernels can be stored dried, salted or frozen.

Butternut (real size)



Section through showing shell (pericarp) and kernel

Pests and diseases

Walnut blight (*Xanthomonas campestris* pv.*juglandis*) does not attack butternut.

Butternut canker

A serious disease in North America caused by the fungus *Sirococcus clavigignenti-juglandacearum*. Symptoms are dying branches, discoloured bark, and cankers on twigs, branches and trunk. Young cankers appear sunken, dark and elongated and ooze a thin black liquid in spring. Older cankers are large and may be covered with shredded bark. Several cankers may coalesce and girdle a tree causing its death. This disease is decimating much of the butternut population in its native range, but resistance is occasionally occurring.

Walnut bunch

Caused by a mycoplasma-like (virus-like) organism, this causes witches brooms (clusters of wiry twigs on branches). Butternuts are quite susceptible in North America.

Dieback

Caused by the fungus *Melanconis juglandis* , this is chiefly a butternut disease (though other walnuts are sometimes affected). It causes a slow dieback of branches, with no well-defined symptoms (no wilting of leaves or cankers). Trees growing weakly are more susceptible.

Walnut leaf blotch

Caused by the fungus *Gnomonia leptostyla*. Also known as Walnut anthracnose, and common leaf spot fungus; synonyms *Marssonina juglandis, Marssoniella juglandis*. Less serious on butternut than walnut.

This occurs throughout Europe and North America on black and common walnuts and butternut; it is widespread in Britain, and common in nursery conditions. The fungus causes brown blotches on leaves and young fruits; severe attacks result in defoliation and the blackening of the young green nuts, which fall prematurely. The disease appears in late May-early June and is favoured by wet weather. Spores overwinter on dead leaves on the ground.

Control is fairly good by mowing over or raking up fallen leaves and burning or composting at high temperatures. In wet seasons when infection is bad, copper-based sprays such as Bordeaux mixture give effective control. Resistance varies widely in cultivars.

Insects

North American minor insect pests include the walnut caterpillar (*Datuna integerrima)* and fall webworm caterpillar which attack leaves; and the butternut curculio or walnut weevil (*Conotrachelus juglandis*), whose larvae feed on young stems, branches and immature fruits, and which is sometimes serious in Canada. Walnut husk flies (a problem on walnuts) do not usually attack butternut.

In Europe and Britain, minor pests include the red spider mite (*Panonychus ulmi*) and the European fruit lecanium (*Lecanium corni*). These are also found in North America.

Birds

In North America, the Purple Grackle can be a pest, often destroying immature fruits by pecking at the green husks.

In Britain and Europe, Crows may dig up seed nuts and attack nuts on trees. Seed beds should be well netted. Sharp noises will repel birds but devices must be shifted frequently; the only other option is shooting.

Grey squirrels

These are a serious pest in Britain and North America, and may take nuts from trees. It is illegal in Britain to trap grey squirrels and release them elsewhere.

Poison baits in hopper systems are commonly used, but the drawbacks - spilt bait can be eaten by other animals and the poison may enter the food chain - make them unacceptable to many. A squirrel contraceptive pill is being developed which may make humane control possible in the near future. The only other options for direct control are to reduce numbers by shooting or trapping. If squirrels are a problem, it is vital to keep the ground cover short beneath trees.

Cultivars

Improved varieties, chosen for larger size and/or with improved shelling (cracking) qualities, have been selected from wild trees over the past century or so and maintained by grafting; but the species hasn't been seriously commercialised. Most selection took place between the two world wars, primarily as a result of enthusiasm by the Northern Nut Growers Association (NNGA). Many of these selections have probably been lost - only a few are available from commercial nurseries now.

Most of these cultivars crack out about 20 % kernels (of whole nut) and those which crack very well will mostly crack out quarters after one cracking.

Aiken: Origin: New Hampshire. Alverson:

Origin: Michigan.

Ayers: Nuts medium sized, high % of kernel. Tree upright, vigorous, late flowering, resistant to walnut leaf blotch. Origin: Michigan.

Baker: Origin: Massachusetts.

Bear Creek: Nuts crack very well, medium sized.

Beckwith: Nuts medium sized, crack quite well. Tree a prolific cropper, moderately vigorous, resistant to walnut leaf blotch.

Bliss: Superior nut. Origin: Vermont. Bohn: Origin: Wisconsin.

Booth: Nuts crack well, medium sized. Tree vigorous, moderately susceptible to walnut leaf blotch. Origin: Ohio.

Bountiful (Syns. Loumis, Stark's Bountiful): Nuts mild flavoured, easily cracked and shelled. Tree a heavy cropper, self fertile, flowers are frost-resistant. Origin: Missouri.

Buckley: Nuts are very large, crack quite well, and kernels are of good quality. Tree very vigorous has some resistance to walnut leaf blotch. Origin: Iowa.

Chamberlin: Nuts medium-large, crack moderately well; kernels moderately well filled, good quality. Tree moderately vigorous, susceptible to walnut leaf blotch and dieback. Origin: New York.

Craxezy: Nuts medium sized, easily cracked, well-filled and kernels are of good quality. Tree yields well, has some resistance to walnut leaf blotch, moderately susceptible to dieback. Origin: Michigan.

Creighton: Nuts small-medium sized, crack very well and well-filled, late ripening. Tree vigorous late to leaf out and lose leaves in autumn; resistant to walnut leaf blotch. Origin: Michigan.

Deming: Origin: Connecticut.

Doud: Origin: Indiana.

Edge: Good cracker. Origin: BC.

Fort Wood: Nuts hard to crack. Tree productive, easily grafted. Origin: Missouri.

George Elmer: Nuts of medium size, rounded, good quality, crack well. Tree vigorous, susceptible to walnut leaf blotch.

Gray Road: Nuts large, crack moderately well. Origin: Indiana.

Helmick Henderson #1: Tree has very good timber form. Origin: Illinois.

Henderson #2: Tree has very good timber form. Origin: Illinois.

Henick Hergert: Nuts superior. Origin: Minnesota.

Herrick: Nuts large. Origin: Iowa.

Irvine: Origin: Wisconsin.

Ivanhall: Nuts superior. Origin: New York.

Johnson: Nuts crack well. Origin: New York.

Kenworthy: Nuts large, crack well, good flavour. Tree small, a heavy bearer, precocious, resistant to walnut leaf blotch. Origin: Wisconsin. May be a buartnut.

Kinneyglen: Nuts medium sized, crack very well, well filled. Origin: New York.

Lingle: Origin: Pennsylvania.

Love: Nuts small, crack well, good quality. Tree vigorous, precocious, resistant to walnut leaf blotch. Origin: Michigan.

Luther: Origin: Michigan.

Mandeville: Nuts superior, crack well. Origin: New York.

My Joy: Nuts medium sized, crack very well, well filled.

New Discovery: Nuts crack well. Origin: Minnesota.

Painter: Nuts very large. Origin: Pennsylvania.

Robinson: Origin: Illinois.

Sherman: Nuts superior. Origin: Massachusetts.

Sherwood: Nuts are well-filled and kernels are of good quality. Precocious tree. Origin: Iowa.

Simonson: Origin: Wisconsin.

Smith: Origin: Michigan.

Thede: Origin: Michigan.

Thrill: Origin: Wisconsin.

Utterbach: Origin: Iowa.

Van der Poppen: Origin: Michigan

Weschcke: Nuts medium-large size, crack well, well-filled and kernels are light coloured and of good quality. Yields well. Origin: Wisconsin.

Wright: Origin: Vermont.

Buartnut cultivars

Buartnuts (*Juglans x bixby*) are hybrids between the butternut and the heartnut (*Juglans adantifolia* var. *cordiformis*). They combine the adaptability, cold tolerance and sweet flavour of butternut with the high yields, easily cracked shells, and shapely branches of heart nut. They are vigorous trees growing to 25 m high and were first bred in British Columbia in the early 1900s.

Barney: Nuts large, difficult to crack; early ripening. Tree vigorous, productive. Origin: British Columbia.

Butterheart: Nuts heart-shaped, crack well, kernels rich. Tree precocious.

Coble's No 1: Nuts large, quite hard to crack. Tree a slow bearer. Origin: Pennsylvania. Corsan: Nuts round. Tree vigorous, productive. Origin: Ontario.

Dooley

Dunoka: Nuts variable in size, 25% kernels. Tree an annual cropper of light crops. Origin: Ontario.

Fioka: Nuts small, crack out well, to 24% kernel, butternut flavour. Tree vigorous, an annual cropper. Origin: Ontario.

Hancock: Nuts of average flavour. Large spreading tree. Origin: Massachusetts.

Mitchell: Nuts medium sized, crack well, good flavour. Tree a good bearer, precocious, often self-fertile. Origin: Ontario.

Van Syckle: Nuts large, cracks well in halves. Tree a heavy bearer. Origin: Michigan.

Walilick: Nuts of good flavour. Origin: Indiana.

Propagation

Cultivars are propagated by grafting, usually onto black walnut (*Juglans nigra*) rootstock (which is reported to encourage earlier bearing than butternut stock). Grafting is quite difficult and may require the use of a hot grafting pipe; techniques used include splice grafts, chip budding and greenwood tip grafts. The Beineke side graft has been used with some success.

Seeds require 3-4 months of cold stratification, and germination may be improved by carefully cracking the shells before sowing. Autumn sowing is also effective, but make sure that rodents can't get at the seeds. A 50% germination rate is pretty good. Seedlings of named varieties will inherit many of their good qualities, for no breeding work has been done on butternuts and cultivars are just superior wild trees. There are on average 66 seeds/kg.

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WHERE NEXT FOR BUSH FOODS?

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As we reach the dying years of the 20th century, it behoves us to look not only towards the future and the promise of the new millennium, but to review the past for the lessons to be learned from what has gone before.

When we narrow our focus to what are commonly called bush foods, some definite trends become apparent. Even excluding animal based foods, which are not at this point within our sphere of interest, it is obvious that the general level of public awareness regarding our indigenous plant foods has steadily risen during the past 20 or so years. For this, read level of awareness within the urban population centres of the coastal fringe, particularly the south-east, and to a lesser extent, the south-west of Australia.

Awareness, and a certain accompanying knowledge, has existed in rural and outback areas since the days of the early European settlers, though many people chose, for all sorts of reasons, not to act on this awareness. When they did, it was generally in relation to a few desirable species such as Quandongs or Bunya Nuts, or as a response to adversity, such as was the case during the Great Depression. Of course, traditional Aboriginal communities continued to make use of their local plants as they always had.

So what bridged this rural-urban gap during the 1980's? The quick answer is probably that a few enterprising individuals, for example Vic Cherikoff, saw an economic opportunity and proceeded to act on it, with varying degrees of success. However, it was far more than this.

Firstly, the increased interest in Australia's history and cultural heritage in the lead up to the Bicentennial Celebrations certainly created a receptive atmosphere in our society. Secondly, an enhanced level of appreciation of Aboriginal culture and traditional knowledge reinforced this state of mind.

The expansion in tertiary education, with the establishment of new universities and non-traditional courses, meant opportunities for academic research. This took place not only in history and botany, but in many related fields such as ethnobotany, human nutrition, and the chemical composition of foods, and resulted in a wave of new publications in these disciplines. These publications were increasingly aimed at a general readership, as opposed to academic, and the format and presentation became more attractive and "user friendly" as the market grew.

Then, the rise in disposable incomes and the proliferation of restaurants in Australian cities established a potential market for new and different foods, the way already having been paved by the upsurge in various Asian and other cuisines. There was, in addition, a widespread interest in food almost as an art form.

Lastly, the 80's were also the decade of the pioneering work, with the Australian army, of Les Hiddens, the archetypical "Bush Tucker Man", subsequently made famous by his hugely popular series of that name on ABC television. It was probably this, as much as anything, that "spread the word".

To begin with, the bush foods supplied to restaurants and manufacturers were all wild gathered, but it soon became obvious that if the fledgling industry were to be more than a flash in-the-pan novelty, wild harvesting was unsustainable, and the crops would have to be farmed.

This then meant nurseries to supply plant stock, which in turn meant quests for superior forms and research into propagation methods before potential producers could establish plantations, and then a substantial time lapse before farmed produce became available.

It is in the fields of disseminating knowledge of species, and propagation methods, that SGAP (Society for Growing Australian Plants) has been most active, and the society's contribution has been considerable.

So where are we now as we approach the 21 st century? Certainly, the various strands of what could loosely be called the bush food industry have tended to coalesce into recognisable categories and become more defined, and a definite separation between the professionals, the amateurs, (and traditional Aboriginal communities who are often both), has become apparent.

The professionals include gatherers and wild harvesters, growers, product brokers and wholesalers, propagators, wholesale and retail nurseries, scientists, consultants, academics, manufacturers, restaurateurs, chefs, retailers, authors and publishers.

The knowledgeable amateurs, of whom SGAP members are the core, learn and experiment out of love and curiosity. Because we don't have to produce a commercial return, we enjoy a freedom not available to the professionals. If and when we have knowledge to share, it generally passes into the public domain. Therefore, in spite of the commercialisation of many of the indigenous plant foods of Australia, we amateurs still play an essential role. Most of the pioneering work of identifying possible species and initially propagating them was and is our contribution.

So, of all the many hundreds of plants with edible parts, which ones are most widely known and consumed in this, their country of origin? These are not necessarily the same thing of course. Most older Australians know that Burke and Wills starved to death on Nardoo (an Aboriginal plant food made by grinding the sporocarps of the aquatic ferns of the genus *Marsilea*), but few have ever tasted it. On a different tack, most people know the Macadamia Nut, but many are unaware that it is a native - the Queensland Nut of my generation's childhood.

Therefore, what species could be regarded as the market leaders in the field? Let's take a closer look at some of those that qualify.

Syzygium luehmannii, the Small Leaved Lillipilly, is marketed commercially as Riberry. The pink-red pear shaped fruit 10-15 mm long are produced on a beautiful, highly decorative small tree. They taste of cinnamon and cloves, can be used in savoury and sweet dishes, and are generally sold frozen or as manufactured items such as sauces and preserves. They have

been extensively planted as street and garden trees in southeast Queensland. Various other members of the genus *Syzygium* and *Acmena* are also marketed as Lillipillies, but do not yet enjoy the same popularity.

The closely related *Eugenia reinwardtiana* or Beach Cherry is a very popular fruit in coastal Queensland, and is a desirable garden shrub with its shiny green leaves, scented white flowers and glossy red fruits.

Eremocitrus glauca is the Wild or Desert Lime which grows on a small, prickly, almost leafless tree. The fruit can be quite variable in size, from 10 to 30 mm in diameter, and light green or yellowish in colour with a thin skin. It is used whole or sliced, and sold frozen or as marmalades, sauces, dressings and seasonings. Because the trees are slow growing, experiments are being conducted involving grafting limes to exotic citrus rootstock in an effort to reduce the waiting time for the first harvest.

Another fruit with a citrus flavour, though it is not a citrus, is the Lemon Aspen or *Acronychia acidula*. This pale yellow fruit 20-25 mm in diameter has small black seeds and a grapefruit/lime flavour. It is sold frozen or as juice or syrup, as well as in dressings, sauces, marinades and desserts.

Davidsonia pruriens is the Davidson's Plum, which comes in two subspecies - *pruriens* and *jerseyana* from Queensland and the Northern Rivers respectively. The fruits are deep burgundy with a bluish bloom, and a high ratio of flesh to seed. The flavour is very tart plum, and it is usually sweetened and cooked in some way such as in sauces, dressings, desserts and preserves. It also makes a beautiful wine. Fruit is sold frozen. The trees are tall, large-leaved and frost sensitive.

Podocarpus elatus is sometimes known as Brown Pine, but is commonly marketed as Illawarra Plum. It is actually the swollen stem of the fruit, which is a small, hard seed which appears to hang off the bottom of the deep purple "plum" with its bluish bloom. The flavour is tart and plum-like, but less sour than the Davidson's Plum, with a pleasant, subtle resinous quality. Fruit should be blended or diced before cooking (use stainless steel utensils - never aluminium!), and add lemon juice or vinegar. Illawarra Plum compliments chilli and garlic in sauces and preserves, and has sweet uses in jams and jellies, fruit compotes, muffins and cheesecakes. It's usually sold frozen, but fresh fruit is often available in season in parks and gardens.

The third of the so-called plums, and the least commercially developed, is the Burdekin Plum (*Pleiogynum timorense*) of Queensland. Quite well known and still eaten in the country, its biggest disadvantage is the comparatively large woody seed and the widely varying quality of wild fruits. There are red fleshed blood plums and the sweeter ones which are green/white inside. It can be eaten out of hand (after holding for some days after picking), makes good preserves and a reasonable wine. At present it appears to be available only in manufactured goods.

Terminalia ferdinandii or the Kakadu Plum doesn't look like a plum at all, being small and pale green with a cling stone that necessitates the mildly apricot flavoured flesh being sliced free. It is its extremely high Vitamin C content that is the main selling point of this fruit, which is marketed frozen, in preserves and in icecream.

Moving on from the native plums to the native peach or Quandong (*Santalum acuminatum*) we reach one of the best known and most popular Australian fruits. A native of the arid inland, the Quandong is a partial root parasite whose large red fruits, with their sweet dry flesh, are highly prized. Sold whole or halved, frozen or dried, and in all sorts of preserves, this is one of only two indigenous food plants to have been the subject of extensive organised research (largely sponsored by CSIRO in its early stages), with the result that there are now many commercial producers, and an Australian Quandong Industry Association. The nut kernels are also edible and commercially available.

Morinda citrifolia, Cheesefruit or Great Morinda, is a soft pulpy edible fruit when ripe, smelling and tasting strongly of blue vein cheese and pineapple. It is sold as frozen juice for flavouring cream sauces, pasta, polenta, dips, marinades and dressings. However, it is the medicinal uses of the plant which have been the focus of major commercial development. Traditional Aboriginal uses included as an antiseptic and wound dressing, for colds and for diarrhoea, and a yellow dye was extracted from the roots. It is now being marketed as Tahitian Noni for the alternative health care market, as an antibacterial, analgesic, anticongestive, antioxidant, anticatarrhal, anti-inflammatory, astringent, emollient, laxative, sedative, hypotensive, and blood purifying agent.

Rubus probus (syn. *R. fraxinifolius, R. muellerii*), the Wild, Queensland, or Atherton Raspberry, is sometimes sold fresh at local markets, sometimes frozen, but usually as jam, syrup or vinegar. It bears heavily, but like its temperate counterpart of European origin, requires fairly intensive maintenance and hand harvesting as the fruit is easily spoiled. Its big advantage is its tolerance of comparatively high temperatures.

Another fruit borne on a low prickly bush is *Capparis lasiantha*, the Nipan or Split jack. Very popular in the country, it has potential rather than current commercial value, though there is some marketing of frozen pulp.

And finally, at ground level, we find the Pigface or Beach Banana, *Carpobrotus glaucescens*, a very palatable fruit grown on sandy soils. The fleshy leaves are also edible, but it is the soft fruits which are generally sold frozen.

Nuts and seeds have the advantage of easier transport and storage than fruits, and generally higher nutritional content by volume. Some of the most exciting and unexpected developments in bush food research is with these items.

The Macadamia Nut owes its early commercial development not to Australia but to Hawaii; hence the very un-Australian names of many of the current plantation varieties, some of which are selected cultivars of *Macadamia integrifolia*, and some of which are hybrids. The Macadamia is a rich, oily, straw-coloured nut encased in a thick, hard spherical shell. The nuts are sold dry, roasted, as savoury snacks and in confectionery, whole or in pieces. Macadamia oil is used as a flavouring oil in salads, dressings and pasta. There is an Australian Macadamia Society of producers who, through industry levies, are funding Australian based research relevant to their needs.

Kurrajong coffee, made from the heavily roasted seeds of *Brachychiton populneum*, was widely used by early European settlers, and Aborigines ate the toasted seeds. Kurrajong flour made from roasted seeds is commercially available, and used to flavour breads, pancakes, muffins and similar items. Lightly roasted seeds can be cooked with rice for a nutty flavour and texture.

The Australian equivalent of the starchy European chestnut is the Bunya Nut, *Araucaria bidwillii*, so important to the Aborigines that it was illegal to cut the trees on Crown Land in the nineteenth century, and it was recommended as a plantation species for food and timber as early as 1889. The Bunya Pines are very large, straight trunked trees with a characteristic rounded crown. The nuts are still eagerly sought after wherever they grow by those in the know, and can be purchased as frozen wholes or halves from bush food suppliers.

Acacia or wattle seeds were among the staples of the indigenous people of the inland, and recent research has revealed that many species are extremely nutritious; so much so that they are being used in reafforestation projects in Africa where food and fuel are high priorities. Some seeds such as *Acacia coriacea* are eaten green, others such as *A. aneura* and *A. holosericea* are milled. Dark brown wattle seed flour with its chocolate/coffee/hazelnut flavour is used as a flavouring in many different applications, both sweet and savoury, and as a hot drink, and is sold both ground and in manufactured products. Other edible varieties include *A. stenophylla* and *A. victoriae*.

Leaves are also economically important. *Backhousia citriodora*, Lemon Myrtle or Lemon Ironwood, is a leaf crop harvested from a handsome rainforest tree, with a distinctive lemon flavour. The leaves are sold fresh chilled, whole dried, ground dried, or as an ingredient in products such as flavoured oils, syrups, pasta, preserves, teas and seasonings. As a bonus, they can be used in pot pourri and scented sachets. The tree in flower is not only a sight to behold, but a powerful butterfly attractant in the garden.

Its cousin, the Aniseed Myrtle or *Backhousia anisala*, has smaller, darker, wavy edged leaves with an aniseed or Pernod flavour with a sweetish aftertaste. Like the Lemon Myrtle, the leaves are sold fresh chilled, and dried whole or ground. They may be used whole, like Bay leaves, in teas, or as a garnish in vinegars and oils. Ground Aniseed Myrtle is an extremely versatile flavouring for a variety of savoury and sweet dishes.

And finally, back to ground level again with two low growing leaf crops - one a vegetable, the other a herb.

Tetragonia tetragoniodes, now marketed as Warrigal Greens, but previously known as New Zealand Spinach or Botany Bay Greens, is often available fresh as well as frozen. It is cooked as spinach or Asian greens, blanched in salads, or used in pesto, quiches, stuffings and pasta. The plants grow naturally in sandy coastal soils and in the inland, assuming almost pest status in some broad land agricultural areas. It is quick growing and in demand in the restaurant trade. This was, in fact, the first indigenous food plant to be exported, growing in cottage gardens in Europe throughout the 19th century.

Native thyme or basil, *Occimum tenuiflorum*, is a purple-flowered herb of the inland with a flavour which is a combination of thyme, tarragon and rosemary. It is sold dried and ground, and is used as a seasoning in all sorts of savoury dishes. At present, it is wild harvested.

There are now a number of bush food and new crop producer organisations and networks, and most state primary industry departments have some support mechanisms available. Specific information is how more widely available than ever before. Publications are shifting focus from general interest to commercial production and farm management, and so the wheel turns.

In conclusion, there are compelling arguments in favour of increasing the biologically diversity around us, including our dietary choices. Choosing to grow and consume bush foods is one way of achieving this desirable outcome, as well as placing a value on wild areas as future sources of foods and medicines. In addition, there is the economic promise of new crops, and the lack of competition from overseas producers. Growing native species in mixed systems can provide habitats for native fauna and reduce reliance on the present standard few food crops, and the constant threat of a pest or disease with the potential to wipe out an entire harvest. Perhaps the twenty-first century is past time for this desirable state of affairs to become a reality.

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Australian Food Plants Study Group: <A2894>

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WHAT CAUSES LOW OIL YIELDS IN OLIVE PROCESSING?

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A recent newspaper article used the sensational headlines "Anger On Olive Yields" to promote the cause of two growers who, through lack of experience, were disappointed with their oil yields from their first-ever olive crop. Their yields of 1% to 5 % oil from Manzanillo, combined with inadequate yields from other well-proven olive varieties, clearly showed their current inexperience in the production of olive oil.

Instead of going back to the freely available and comprehensive books, journals and reports on techniques for maximising oil yields, they chose to blame the variety of olive and the supplier of the trees and took their complaints to the media. While the article made references to Australian growers who are happy with their Manzanillo crops and oil yields, its sensational headlines did nothing for the public's view of Australia's excellent olive industry.

The above situation makes it timely for a summary on the need for correct management of olive groves, right from flower set in spring through to the final pressing in late autumn and winter.

Olives Australia's mother trees, from which our Manzanillo plants are grown, have been yielding between 15% and 20% oil at correct fruit maturity for a number of seasons. These Extra Virgin oils are extracted without the use of excessive heat, solvents, chemical additives, prolonged storage or any similar techniques. They are simply 'olives in and oil out'.

Laboratory oil contents of fruit from the same Manzanillo mother trees over the past two seasons (at the correct harvest dates), have resulted between 17.6% and 23.7% oil. (These laboratory results are from whole fruit using the Soxhlet laboratory method, standardised to 50% moisture.)

As the industry matures, growers and processors will learn that each variety of olive has specific cultural and processing requirements to maximise product quality and quantity. While this fact is 'old hat' to people in the established olive countries and the experienced olive growers and processors in Australia, for new arrivals it must be learned - preferably from books and other's experience, but sometimes from first-hand experience.

The three main factors which led to the low yields in these new groves are:

1. Moisture Management - excessive moisture in olives reduces the oil extraction efficiency.

2. Harvest Timing - picking prior to full oil accumulation reduces oil availability and yield.

3. Processing Temperatures - processing olives at temperatures well below recommended guidelines leaves large volumes of oil in the waste paste.

Let's look at the specific cultural practices for the dual purpose Manzanillo olives to show how each variety has specific needs. Whether you are growing Frantoio, Picual, Barnea, Picholine, Correggiola, Hojiblanca, or any other commercial variety, these techniques can directly affect your profits.

According to Fernandez, Diez & Adams (1997), Manzanillo olives are now grown commercially in Spain, USA, Argentina, Portugal, Mexico, Israel, Tunisia, Chile, Cyprus, Australia, New Zealand & South Africa.

There are literally dozens of texts, reports and scientific studies which outline the heavy cropping, dual purpose nature of Manzanillo trees and the high quality of their products.

Moisture management

The Manzanillo has been grown as an excellent dual-purpose olive for over four hundred years. The first reference to its quality table olives and oils was made in *Historia de Sevilla* by Alonso Morgado in 1587.

As a dual-purpose olive it has a tendency to accumulate moisture from the soil more efficiently than other varieties. For table olive production this is commendable but for growers using it for oil the irrigation should be scheduled to maximise percentage yield.

The use of Reduced Deficit Irrigation (RDI) is a proven technique for both saving water and increasing extraction efficiency and percentage yields in Manzanillo, and is quite likely also of real value for oil-specific varieties such as Frantoio, Leccino, Picual and others. (See article by Goldhamer in Australian Olive Grower, September 2000, Issue 18 for more details.)

Moisture levels in fruit being used for oil extraction should be kept below 65% to ensure reduced emulsion levels (which bind the oil and water tightly together) and to allow efficient extraction. The groves which have been having trouble extracting oil from Manzanillo this season had moisture contents of around 74% to 78% in their fruit - extremely high. This had drastic effects on the extractability of the oil which the laboratory tests showed was present in the fruit, and also, unfortunately, in the waste paste after the olives had been processed.

An Argentinean olive grower and processor in charge of over 250,000 trees reported in 1999, "If water levels are greater than 60% in the fruit they can only extract 6-7% oil. Therefore they must not over-irrigate the trees before harvest." No variety was given but the varieties grown on the property concerned are Arbequina, Manzanillo, Frantoio, Coratina, Empeltre, Picual and Mission.

In regard to the effect of summer rainfall on oil extraction percentages, laboratory tests and manual extraction results on dual-purpose Manzanillo fruit grown in summer-rainfall regions of southern Queensland have shown that standard extraction yields of 15-20% can still be expected. It is only when summer rainfall is excessive, or is combined with excessive or wrongly timed irrigation, that oil yields will drop to unacceptable levels, a factor common to all olive varieties.

Harvest timing

After the three or four years of laborious grove management since planting, one of the pitfalls of seeing the first olive crop is the desire to 'get it off the tree and into the press' as soon as possible. For a number of growers this has led to disappointing yields from olives picked too soon.

A comment made by experienced Australian processor Jim Smyth, and others, is that olives grown in Australia seem to change skin colour faster than they accumulate their oil inside. The reason for this unknown but the result is black olives on the tree that are still not carrying their full oil yield. Assessment of oil yields at various stages of ripeness in coming seasons may show that some regions need to leave their olives on the trees until a more mature stage to accumulate the same oil as other areas.

To understand the best harvest dates for each variety in your grove, contact a local processor who has had many years of local experience. The harvest dates vary greatly between varieties and regions, especially when climatic differences such as those between Inglewoood, Canberra and Margaret River are taken into account.

This fruit is not nearly mature enough for full oil yield

Oil processing temperatures

While there has always been some debate as to the 'correct' temperature for extracting high quality olive oils, the benchmark "Good Manufacturing Practice (GMP) Guidelines for Virgin Olive Oil Production" (Petrakis, 1994) suggests that paste temperatures should not exceed 35 degrees Celsius. Award winning oils which are judged as 'without defect', 'cold pressed' and 'Extra Virgin' are commonly processed at these temperatures. To process at temperatures around 20 degrees Celsius or less might allow for specific labelling and advertising of the fact but is of little comfort for the grower who is wanting to take home many litres of oil.

Being a fat, olive oil becomes more fluid at warmer temperatures and is released more efficiently from the paste during the extraction processes, resulting in higher extraction percentages. From conversations with people involved with the low Manzanillo oil yields reported in the media, it has been confirmed that the olives were processed at below 20°C and possibly as low as 15°C - twenty degrees colder than the GMP figure.

Oil yields

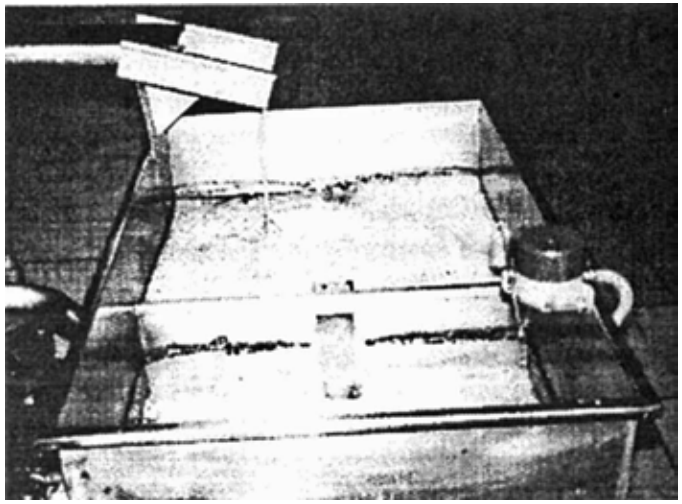
To again use the dual-purpose Manzanillo as an example, the following data lists various olive oil content references. It should be noted that the oil content listed for a variety of olive is usually calculated as a total oil present in a laboratory setting and cannot be equalled through a manual extraction machine. However, a properly operated extraction machine with suitable fruit quality should be extracting around 90% of the listed oil content.

"Manzanilla de Sevilla [The 'strain' of Manzanillo grown most widely in Australia] has a 20.1% oil content and [an oil] stability of 91.8 hours at 98.8 degrees Celsius", according to *El Cultivo del Olivo* [Farming the Olive], by Barranco, Fernandez-Escobar & Rallo (Spain, 1997). This high level of stability ranks it as one of the most stable varietal oils in the world.

In our library alone, there are 11 published sources from California, Spain, Italy and Australia which all report the oil content of the dual-purpose Manzanillo fruit at 20% or greater. The sources are written by some of the most respected, experienced olive industry leaders in the world. In addition there are numerous published sources which do not give an exact percentage but speak of Manzanillo's oil content as either "medium to high", "high". or "in commercial quantities".

An ongoing research trial in Cyprus has compared more than 30 local olive varieties. Manzanillo was used as the 'control/benchmark' variety in the trial. The Manzanillo gave more oil units per tree than any other of the 30 varieties in the trial. (Dr Costas Gregoriou, Agricultural Research Institute. Cyprus. 1999.)

A similar result has been obtained here in Australia where the Manzanillo variety was recorded as the heaviest cropper of 14 varieties planted in the 1969 - 1978 trial at the Sunraysia Horticultural Research Centre in Mildura, and this season Paul McClure has reported that while high moisture levels made extraction more difficult, their experienced processor, Mr Gianni Grigoletto, extracted more than 20 litres of oil from each of the trial's dual-purpose Manzanillo trees.



The oil flows. Processing temperatures play an important role in obtaining good oil yields

Oil quality

Although a traditionally dual-purpose olive, Manzanillo oils have received much acclaim in Californian Organoleptic Oil Assessments organised by International Olive Oil Council assessors. In a blind tasting of 23 oils (5 were from Manzanillo olives), the oil judged most highly was from irrigated Manzanillo fruit. All five Manzanillo oils ranked in the top 10 of 23 and were each graded as "Extra Virgin".

The "Calaveras Manzanillo Extra Virgin Olive Oil" was recently a Californian Olive Oil Council Certification Seal Winner. A Manzanillo blend oil from Argentina has just been awarded a Distinction at a Judging Concourse in Gradara, Italy.

"Manzanillo oil has the rich green colour and abundant flavour characterising the fall harvest varieties, combined with a slight tartness that adds zest to any food --- This oil is known for its distinguished olive character and fruitiness --- perhaps more than any other of our varieties, Manzanillo Organic gives you all the olive flavour without the olive." Nick Sciabica - one of California's most experienced and respected olive oil processors.

According to laboratory research by Barranco, Fernandez-Escobar & Rallo (Spain), 1997, Manzanillo oil is more stable than other well respected varieties such as Arbequina, Frantoio & Leccino. Whilst each varietal oil has its benefits, good stability is most beneficial to maintaining oil quality as it allows the oil to store for longer periods in storage or on the shelf prior to deteriorating.

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One or more of the above factors has caused much stress to some first time growers this season. Their extraction results of I % to 3 % oil from early harvest Manzanillo olives, with 12.8 % oil remaining in the waste paste, 3% - 5 % oil from mid/late harvest Manzanillo olives - of the 23% oil present, and 8% oil extraction from mid/late season Frantoio olives with 11% oil remaining in the waste paste, highlights the effects that moisture levels, harvest date, selection and extraction techniques can have on profitability. (These two laboratory results were calculated using whole fruit waste paste or the whole fruit themselves, using the internationally-recognised Soxhlet laboratory method, standardised to 50 % moisture.)

As with any emerging horticultural industry there is still much to be learned by all of us involved. Olives Australia will continue to research, operate trials and publish practical information for growers and processors seeking to make their way in the world of the olive. We wish you the very best as we continue to work together to build a great olive industry in Australia for the health of the world.

[Based on an insert with an issue of *Australian Olive Grower*, October 2000]

Olives Australia: <A2771>

MEDICINAL AND BIOPESTICIDAL PLANTS OF INDIA

GOKAL CHAND
Green Gold International
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Indian plants yielding eco-friendly bio-pesticides

Neem (***Azadirachta indica***): It is the most promising source of biopesticides. Neem owes its toxic attributes to a large number of bitter compounds called meliacins like azadirachtin, nimbin, salannin, meliantriol, etc., among which azadirachtin is the most potent one. Neem seed kernels are richest source of meliacins and contain 0.2-0.3% azadirachtin and 30-40% oil, though neem leaves, seed coat and bark also contain these but in smaller quantities. The neem has been found effective against more than 200 pests. Neem cake is in great demand as a fertilizer, which also kills various plant parasitic nematodes.

Chrysanthemum (***Chrysanthemum cinerariefolium***): Pyrethrum is extracted from dried flowers of chrysanthemum (*Chrysanthemum cinerariefolium*). It has a rapid knock down effect on flying insects and is very effective against house hold pests, and fleas on domestic pets and human life.

Derris & Lonchocarpus : Rotenone is derived from the rhizomes of tropical legumes Derris and Lonchocarpus. It has been used as a traditional fish poison since last 300 years. It is effective against household and kitchen garden pests.

Tobacco (***Nicotiana tabacum***): It was widely used for insect control in agriculture before second World-war. But, it is not preferred today owing to its appreciable vertebrate toxicity.

Champac (***Michelia champaca***): The extract from flowers of champac tree is very potent against mosquito larvae.

Lantana (***Lantana camara***), **Tulsi** (***Ocimum basilicum***), and **Vetiver** (***Vetiveria zizanioides***): The leaf extracts of lantana, tulsi and vetiver are useful for controlling leafminers infesting potato, beans, brinjil, tomato, chillies, crucifers and onion.

Marigold (***Tagetes erecta***): The crushed roots of marigold (*Tagetes erecta*) provide good control of root knot nematode, when applied to soil.

Custard apple (Annona squamosa): The seed extract of custard apple is efficacious against diamond back moth.

Grapefruit (***Citrus paradisi***): The seed extract of grapefruit can be used to control Colorado potato beetle.

Darek (***Melia azedarach***): The bark extract of darek tree acts as potent antifeedants against tobacco caterpillar and gram pod borer. The compounds from darek are highly safe to vertebrates.

Lemon grass (***Cymbopogon citratus***), **Argemone** (***Argemone mexicana***), **Cassia** (***Cassia occidentalis***), **Artemisia** (***Artemisia absinthium***), and **Sigesbekia** (***Sigesbeckia orientalis***): The leaf extract of these plants are strong antifeedants of caterpillar.

Garlic (***Allium sativum***), and **Black pepper** (***Piper nigrum***): Garlic acts as a repellent for various pests. The powder of garlic cloves can also be dusted on plants for warding off pests. The powder of dried garlic leaves, mixed with ash protects materials in storage. Seed extract of black pepper have shown promise for control of agricultural pests.

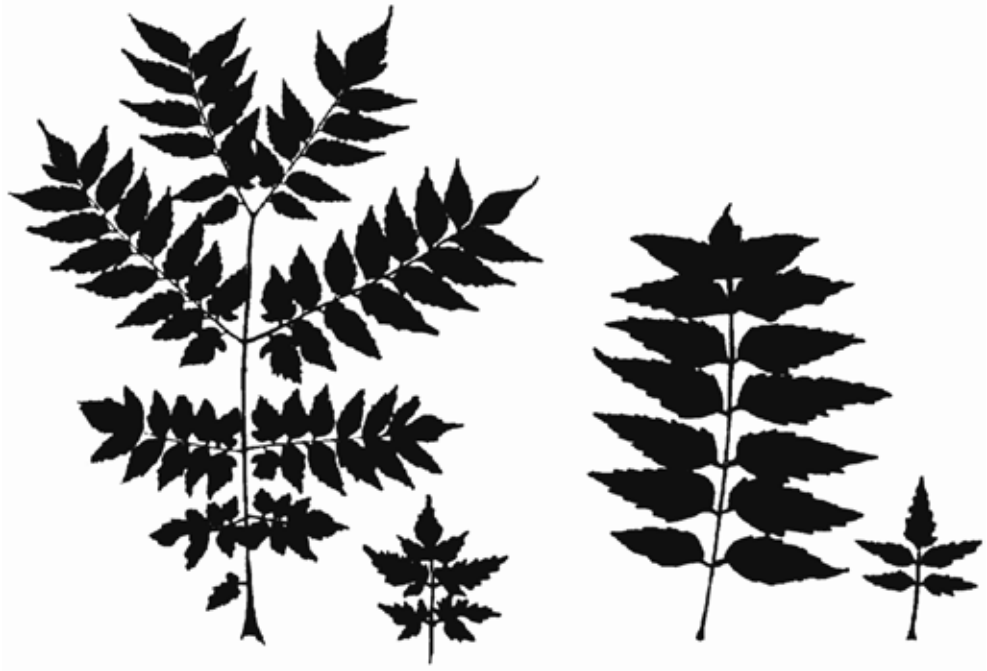
Drum stick (***Moringa oleifera***): The root extract of drum-stick inhibits the growth of several bacteria. It is, therefore, used to preserve fruit and vegetables and to treat seed.

Bael (***Aegle marmelos***), **Nochi** (***Vitex negundo***), **Opuntia** (***Opuntia dillenii***), and **Jatropha** (***Jatropha curcas***): The leaf and fruit extracts of bael, leaf extract of nochi, opuntia and jatropha are effective against various pests.

Pongan (***Pongamia pinnata***): The leaves of pongan and nochi are also used for controlling pests of stored products and garments.

Adhatoda (***Adhatoda vasica***), **Sweetflag** (***Acorus calamus***), **Milkweed** (***Calotropis gigantea***), and **Madre tree** (***Glyricidia sepium***): Adhattoda, sweetflag, milk-weed, and madre tree contain toxic compounds which are effective against various pests.

Their harmlessness to non-target organisms and environment makes these biopesticides suitable for integrated pest management.



*Sapling and seedling leaf shapes in (left): Neem (*Azadirachta indica*) and (right) Darek, White cedar or Cape Lilac (*Melia azedarach*)*

Native Indian medicinal & aromatic plants

1. Plants of subtropical regions

Adhatoda vasica (adusara, bansa, arusi or vasaka): Evergreen perennial shrub; Leaves used for cough, bronchitis and asthma and as it has oxytocin; Root biopesticides.

Anethum graveolens (aethi/dill, sowa): Fruit carminative and digestive used in dyspepsia; Seeds exported.

Apium graveolens (celery, ajmodh ajmodha, khurasani): Fruit used as a sedative, tonic and domestic remedy for rheumatism, and for culinary and flavouring purposes.

Asparagus racemosus (shatavar): Tuberous roots; Anti-oxytocic, prevents threatened abortion, ensures safe delivery.

Azadirachta indica (margosa, neem, Indian lilac): Elegant evergreen tree; Fruit, seeds, leaves and bark yield broad spectrum of pesticides, which annihilate several pests.

Catharanthus roseus (sadabahar): Leaves anti-cancer properties; Roots hypotensive and antidiabetic.

Coleus forskohli: Leaves contain essential oil with compound foreskohli (coleonol) which is anti hypertension.

Curcuma longa (turmeric, haldi): Rhizome, aromatic, stimulant, carminative, condiment and cleansing; Used for ulcers, sprains, antiinflammatory and anti-microbial.

Datura fastuosa (daturae, thorn-apple): Leaves and flowering tops used in antispasmodic, anodynous, anticholinergic, "truth serum", etc.

Foeniculum vulgare (fennel, aniseed, saunf): Fruit carminative, respiratory, ailments, mouthwash and liquor, antiseptic.

Jasminum grandiflorum (chameli, jasmine): Flowers used in perfumery; Jasminum, essential oil extracted from flowers.

Ocimum sanctum (sacred basil, tulsi/surasa): Leaves used as anti-bacterial, insecticidal, diaphoretic and carminative agent; Expectorant and aromatic herb.

O. basilicum sweet (French basil, niazbo): Leaves used in the perfumery and culinary industries.

O. canum (*Ocimum gratisimum*): Leaves used to extract essential oil similar to clove oil eugenol and methyl amylketone; Used as additive to clove-like oils.

O. kilimandschricum: Leaves used to extract essential oil with camphoraceous component, the camphor is a weak antiseptic, anti prurient and anti-rubefacient; Also used as perfumery agent in incense.

Mentha arvensis : Leaves carminative and antiseptic used in pharmaceutical industry to make nose and throat medicines.

M. spicata (or *Mentha viridis*) (chutney pudina): Leaves carminative and used as condiment and spice.

M. piperita (peppermint): Leaves flavouring; Essential oil peppermint; The oil finds use in pharmaceutical industries.

M. citrata (Bergamot mint): Leaf oil is used in the perfume industry.

Emblica officinalis (*Phyllanthus emblica*) (Indian gooseberry): Extremely hardy tree; Richest source of vitamin 'C'; Useful in liver diseases and diabetes; Fruit helps in indigestion and is stomachic and anti-scorbutic.

Ricinus communis (castor oil plant, rendi, aranda): Very hardy shrub; Fruit used as purgative. Oil used in industry as lubricant and in paints and refined motor oil.

Rosa damascena (gulab, pink rose): Petal contains volatile oil (otto, or "attar", of roses), tannin and colour; Petals used in confection with sugar; "gulcand" used as laxative.

Trachyspermum ammi (ajwain). Fruit used as carminative, stomachic, antiseptic, digestive and anti-spasmodic agent.

Withania somniferum (aswagandha, asgandh). Root, stem bases and seeds used as tonic and aphrodisiac and also in asthma and tuberculosis.

Besides the above commercial species, other important medicinal species are: *Cassia fistula* (tree), *Crataeva nurvala* (tree), *Psoralea coryifolia, Tinospora cordifolia, Nelumbo nucifera, Pluchea lanceolata, Murraya koenighii* (tree), *Aegle marmelos* (tree) *and Feronia elephantum* (tree).

2. Plants of subtropical semiarid regions

Commiphora molmol (commiphora mokul, myrrh of lndia, arabiangogul, gandhras, bol): Stem and bark yield Oleo gum resins which is carminative, demulscent, astringent, diaphoretic, expectorant; Useful as intestinal and lung disinfectant and aphrodisiac.

Cyamopsis tetragonolobus (guar gum): Seeds used as purgative and valuable in diabetes and dysentery; Used as binder for tablets, emulsion-forming; Finds use in food processing and printing industries.

Glycyrrhiza glabra (mulathi): Rhizome yields glycyrrhizin which is 50 times sweeter than sugar. Used in Addison's disease, lowering cholesterol levels, antipyretic, anti-arthritic, antiinflammatory, expectorant; Used for asthma, cough, liver trouble and bronchitis.

Papaver somniferum (poppy, afim): Fruit yields alkaloids morphine, codeine, papaverina, norcotine, etc. Used as pain killer, analgesic, anodyne and for controlled depression of the central nervous system. Syrup of codeine is used for cough and bronchitis; A dangerous narcotic.

Plantago ovata (psyllium, isabgol): Seed and husk used as emollient and demulcent laxative and in cosmetic and icecream industries; Cure intestinal ulcers; India has a monopoly in world trade.

Besides above commercial species, other important medicinal shrub species are, *Calotropis procera, C. gigantea,* and *Aloe barbadensis,* and herbs, *Tribulus terrestris, Alhagi camelorum, Withania somnifera,* etc.

3. Plants of subtropical marshy regions

Acorus calamus (rhizoma acori, calami, bach/bachu/vaj): Rhizome based drugs used as stimulants, carminatives, tranquillisers and tonics, and in dyspepsia, bronchial infections and epilepsy.

Centella asiatica (Indian pennywort, branhmi manduki, brahmi, jal brahmi): Entire herb yields essential oil triterpenoid. Used as a brain tonic and sedative. Also for skin diseases. Antiphlogistic, aperient, amenorrhea and elephantiasis.

Cyperus rotundus (motha, nagarmoth): Bulbous roots used as diaphoretic, anthelmintic emmenagogue and for dyspepsia and dysentery.

Nelumbium speciosum (sacred lotus, kamal, padma): Leaves and flowers used for diseases of the liver, cholera, dysentery, piles, cough. Syrup of flowers used as coolant. Root stock is mucilaginous and spongy, used for ring worm and other skin diseases.

4. Plants of sub montane regions

Adhatoda vasica (adusara, bansa, arusi or vasaka): Evergreen perennial shrub; Leaves used for cough, bronchitis and asthma and as it has oxytocin; Root biopesticides.

Cymbopogon citratus (lemon grass): Aromatic floral shoots used in perfumery; Essential oil citral used as stomachic, febrifuge, stimulant in catarrh and bactericidal; Alfa ionone used in flavouring, cosmetics and perfumery; Beta ionone used for manufacture of vitamin 'A'.

C. martinii (palma-rosa grass): Leaves used in perfumery and as cosmetic and flavouring tobacco and liquors.

C. winteranus (java citronella): Essential oil used in perfumery and the cosmetic industry.

Rauwolfia serpentina (Indian snake root, sarapgandha, chhota chand): Herb; Root, bark and rhizome extracts used for the management of hypertension.

Vetiveria zizanioides (vetiver, khas-khas). Essential oil vetiver from roots is used as coolant in indigenous and modern systems.

Zingiber officinale (ginger, adrak): Oleo-resin extracted from rhizome used in carminative condiment, flavouring and culinary preparations and in confectionary drinks such as ginger, etc.

5. Plants of temperate regions

In the Himalayas there is vast wealth of medicinal plants such as *Nardostachys jatamansi, Atropa acuminata, Thymus serphyllum, Swertia chirata, Valeriana grandiflora, Rheum* spp., *Gentiana kurroo, Picrorhiza kurroa, Centella asiatica, Aconitum* spp., *Dioscorea deltoidea, Taxus bacata, Chlorophytum arundiinaceum, Berberis spp , Cymbopogon* spp., and *Allium* spp.

Achillea millefolium (gandana biranjasif amritdharaghas): Used in flavouring, substitute for hops, decoction given in colic, essential oil used as astringent, tonic and diaphoretic. Used in Liv.52.

Allium carolinianum (Iaot, lahut, jangli lahsun): Leaves cooked as vegetables, and flowers used as condiment. Beautiful ornamental plant.

A. jaquemontii (koche, pharna, jangli piaz): Used as condiment.

Arnebia euchroma (khamet, ratanjot): Used in dyeing/colouring silk, wood, foodstuffs, hair oils, used in eye diseases, toothache, earaches, cuts, wounds and has antibiotic properties.

Artemisia brevifolia (seinski, nurcha, bhurse): Insecticide, santonin obtained from the plant used in bitter pills against hookworms and thread worms.

A. dracunculus (barma, dragon, taragon, mugwort): Oil used for flavouring vinegar, sauce, soups and liquors and in perfumery. Aromatic leaves are used as aperient, stomachic, febrifuge and as spice.

Aquilegia fragrans (lunded dorje, lama): Diuretic, diaphoretic, anti-scorbutic and tranquilliser. Employed for hysteria, dysmenorrhoea and chronic skin troubles. Roots are used for removal of kidney stones. Seeds used as oxytoxic and for jaundice.

Bergenia stracheyi (gatikpa, pashanbneda, patharchat): In Ayurveda, bark is considered acrid pungent, heating, tonic, alexiteric useful in convulsions, bronchitis, diseases of blood, ear and in leprosy. It is antiseptic carminative, given in anaemia, obesity, urinogenital diseases, hysteria, toxemia and infections.

Capparis spinosa (rutokpa, martokkpa, kabra): Pickled flower buds are useful in scurvy. Bark is credited with diuretic properties, useful in infection of liver, rheumatism and paralysis. Seeds yield fatty acids.

Carum carvi (shingu, dru, kalajira): Condiment, aromatic, pungent, stomachic, carminative and useful in flatulence.

Corydalis govaniana (chingti, bhutjata): Root stocks are used as tonic, diuretic in eye diseases.

Dactylorhiza hatagirea (angbolaghpo, panja, salampanja): Roots used as farinaceous food, nerve tonic aphrodisiac. Mucilaginous jelly in diarrhoea, dysentery and chronic fevers. Useful in seminal debility, tonic for women after delivery.

Ephedra gerardiana (chhe, chedang, soma, somlata): Yield famous drug of commerce, ephedrine useful in asthma and respiratory problems.

Fraxinus xanthoxyloides (thumma, pipjul, ash): Decoction of the stems/twigs applied to wounds, cattle wounds and bone fractures.

Gentiana kurroo (tikta, karu, gentian): Root is a bitter tonic, useful in diseases of liver and spleen. Antipyretic, blood purifier and liver protecting drugs.

Hyoscyamus niger (tukhlang, khurasani, ajwain, henbane): Used in nervous affections, asthma and whooping cough, leaves yield hyoscyamine and hyoscine.

Heracleum candicans (heypomo, padara): Roots yield xanthotoxin which is highly efficacious in the treatment of leucoderma and psoriasis.

Hippophae rhamnoides (chharma, tirku, sarla, seabuckthorn): Fruit is a richest source of vitamin C. Jelly is useful for liver and lung complaints and tuberculosis. Seeds yield fatty oil which can be used in high grade paint and varnishes.

Hyssopus officinalis (tengu, tyangu, juffa): Highly scented herb yielding up to one percent essential oil. Flowering tops used in fevers and blood related diseases and as a substitute for saffron.

Juniperus communis (chhershup, shukpa): Its fruits and essential oil are used in dropsy and diseases of urinogenital tract. Berries are used in dry Gin blending and in ayurvedic medicines.

Malva rotundifolia (chhambasa. khubasi): Plant used as pot herb and shoots as salad. Seed useful in bronchitis. Reported to be a remedy in leucorrhoea.

Onosma hispida (pasa. gaojaban. ratanjot): Red dye obtained from roots used for dyeing and colouring foodstuff, regarded as tonic, demulcent, diuretic and refrigerant. Root paste applied to cuts and wounds.

Physochlaina praealta (laltang): Yields atropine and hyoscyamine, which enter into various modern formulations as antidote, sedative, narcotic, anodyne and in dilation of the pupil.

Podophyllum hexandrum (bankakri, shathajalari): Roots yields podophyllin credited with properties to cure skin cancer. Also contains berberine.

Rheum australe (thukla, tukshu, archi): Roots are purgative, astringent tonic stomachic and aperient. Powdered roots used for cleaning teeth and sprinkled over ulcers for quick relief. A potent anti inflammatory drug.

R. moorecroftianum (lechu, leechu, archi, rhubarb): Roots are purgative, astringent, tonic, stomachic and aperient. A potent anti inflammatory drug. Leaves used as vegetables.

Saussurea costus (kuth, costus): Roots have anti-arthritic, anti-septic, aphrodisiac, astringent. carminative, digestive, diaphoretic, disinfectant, emmenagogue, expectorant, narcotic, spasmodic, stimulant, tonic and vermifugal properties. Useful in asthma, bronchitis, colic, cough, dental trouble, hysteria, heart trouble, removing marks and blemishes from the skin, in menstrual problem and promotes urination.

Inula racemosa (manu, poshkar, pushkarmool): Contain inulin and oil having isoalantolactone and dihydroalantolactone. Seeds are aphrodisiac.

Thymus serpyllum (pangdum, khishikpasa, wild thyme, banajawain): Flea repellent, infusion/decoction used in cough, coryza, urinary problem. Oil contains thymol used in a variety of preparations.

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Submission of Articles

The WANATCA Yearbook is devoted to useful longer articles, likely to have continuing reference value, about any aspects of nuts, fruits, and other tree or perennial crops.

Articles would be gladly received from any source - there is no requirement to be a member of WANATCA. If the text is available on a computer or word-processor disc, this is greatly appreciated. Text and enquiries can also be sent by fax or e-mail.

The WANATCA Yearbook is produced at the Tree Crops Centre, Perth, for the West Australian Nut & Tree Crop Association Inc.

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WEST AUSTRALIAN NUT & TREE CROP ASSOCIATION (Inc)

Founded in 1974, the Association has built up a wide membership among professional growers, amateurs, researchers, horticultural bodies, libraries, nurseries, and investors. Members are based throughout the State, all over Australia, and in many overseas countries.

Membership fees cover subscriptions to all WANATCA publications. Currently these are: a quarterly magazine, **Quandong**, and the **WANATCA Yearbook**.

Quandong has details of forthcoming Association meetings, events, and field trips, book reviews, news items of interest, reprints of short articles drawn from world-wide sources, members' comments and queries, and notes on sources of trees, seed, materials and services.

The **WANATCA Yearbook** is our major research publication, with original articles of permanent interest. It is indexed as part of the global coverage of the U.S.-based Biological Abstracts Service.

The **Australasian Tree Crops Sourcebook (ATCROS)** is our major reference work, containing regularly-updated tables of all sorts of useful material about tree crops (common and botanical names, growing conditions, recommended areas etc.), membership lists, lists of useful tree crop organizations world-wide, and a commercial-sources list, acting as a Directory of Tree Crop Services for the whole of Australia, New Zealand, and adjacent areas. Relevant services (e.g. seed suppliers) are listed world-wide. This information has now been updated and converted into a major World Wide Web site on the Internet - address is **<http://www.AOI.com.au/atcros>**.

There are various classes of **membership**. The standard grade is **Full Membership**. It is open to individuals, families, and any form of organization (companies, research units, libraries, etc.). New Full Members will be accepted on application; no entrance fee is charged. **Student Membership** is a concessional rate for current-year students unable to pay full rate. **Sustaining Membership** is a special grade for those supporting the aims of the Association who are able to give extra financial help to achieve those aims. **Life Membership** is available to existing individual members of at least 3 years standing who wish to commute all future payments into a single sum. **Corporate Membership** is open to organizations involved in tree-crop enterprises. **Overseas Members** are welcomed and pay no more, although they may optionally receive publications by air-mail for a small premium.

All subscriptions (except for Life Members) run for a year of four consecutive quarters (1=Jan-Mar; 2=Apr-Jun; 3=Jul-Sep; 4=Oct-Dec). New members may join at any time, and receive all publications for the year. After October 1, new members may join at any time and will receive four issues of *Quandong magazine* and one issue of *WANATCA Yearbook* during the subscription year.

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