

Culinary bamboo shoots

David Midmore

Introduction

Most bamboo species will produce edible shoots. These are the young culms harvested at the time of or shortly after their appearance above the soil surface. The shoots vary in size and degree of bitterness, and most commercially-marketed shoots are derived from a small number of chosen species. Bamboo species may be conveniently split into two groups: the clumping types (Photo 1), with short rhizomes (i.e. underground stems) botanically referred to as sympodial, and the running types (Photo 2) with long rhizomes, referred to as monopodial. Very broadly speaking, the clumping types are adapted to sub-tropical and tropical climates and produce shoots after mid-summer, while the runners are adapted to cooler climates, and produce shoots in spring.

A period of from three to seven years is required between establishing a bamboo plantation and the harvesting of commercial-sized shoots, and at the time of writing, the first harvest season of plantation bamboo in Australia has just been completed. Development

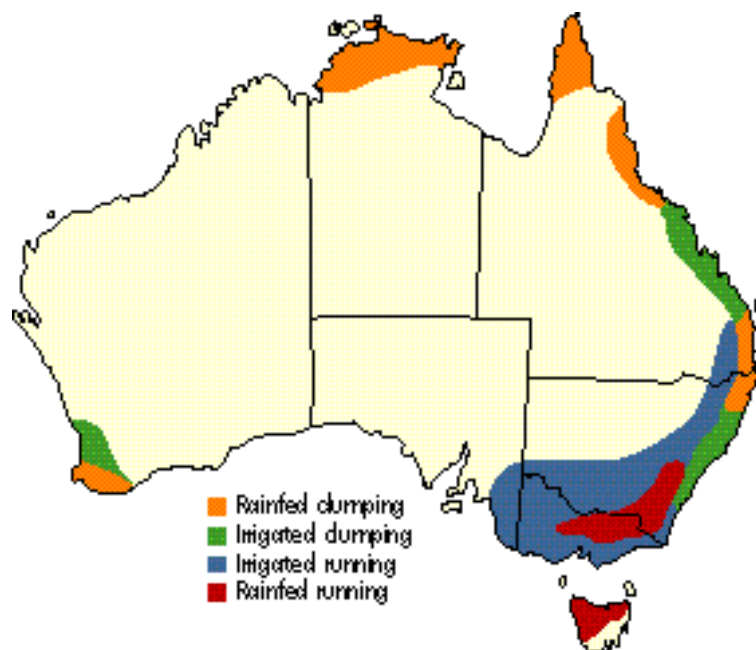
of an Australian bamboo-shoot industry offers opportunity to substitute fresh shoots for the estimated 6,000–12,000 t of canned produce imported annually. As with other seasonally available, perishable vegetable species (e.g. Chinese water chestnuts), bamboo is currently known to be available in the fresh form for a specific period of the year: For bamboo this period is from September until April. Postharvest semi-processing may extend the availability of near-fresh shoots to cover the harvest gap between April and September.

Bamboo shoots are important constituents of stir-fry cuisine and specialised recipes, and are

produced and consumed in great quantities in China, Taiwan, Thailand, Japan and Korea. Taste and presentation vary in different countries. Bamboo shoots are also canned and exported from Taiwan, China and Thailand, and the latter two countries largely supply the world market.

Markets and marketing issues

Until 1996 the Australian market for bamboo shoots, with the minor exception of some 'natural' bamboo clumps, was catered for by imported canned and preserved shoots. A \$6m import value in 1992 estimated



by Dooley was based upon 1990 ABS import statistics for canned shoots (\$3–6m) and calculations of consumption in restaurants and homes (1.35 million kg at \$4.50/kg net). However, 4000 t were estimated to have been imported annually in the early 1980s, a figure which, given the increase in Asian tourists and residents and the change in Australian taste, could well have doubled by today.

About the author



Professor David Midmore has been with Central Queensland University as Director of the Primary Industries Research Centre (see Key contacts for address) for two years. His previous research experience spans vegetable and staple crops in Asia and Latin America.

The net retail price of canned bamboo shoots ranges from \$4 to \$8/kg which represents the absolute minimum retail price that fresh shoots would be likely to command. Currently, farmgate prices of up to \$12/kg have been achieved, but this reflects the limited supply of fresh shoots in Australia. The balance between supply and demand will most

likely take the farmgate price of fresh shoots well below present levels.

In countries where bamboo shoots are traditionally eaten, they rank high in the list of vegetable production volumes (e.g. second in volume in Taiwan), and they are preferably consumed fresh. To supplement the fresh market in periods of local scarcity, Japan imports fresh shoots as well as canned shoots. The months of scarcity for fresh shoots in Japan (November to March) coincide with those of peak production in Australia, which could make Japan a steady market for 250 t shoots/month, with a monthly retail value of \$3.75m. Similar months of scarcity in Taiwan also dovetail with Australia's harvest of fresh shoots. Chinese populations world-wide consume bamboo shoots, so there are in Singapore, Malaysia, Vietnam, the USA, Canada and Europe markets for canned (and in the future fresh) shoots.

Bamboo plantations do not only return a profit from shoots.

Cultivation also produces timber which may be used for furniture, stakes, scaffolding (as, for example, that which supported the construction of the Hand-Over auditorium in Hong Kong in 1997) paper pulp and even disposable chop-sticks. Locally-produced bamboo poles—treated against the bamboo powder-post beetle (*Dinoderus minutus*)—are actively sought by Australian importers of bamboo poles. Some reports suggest poles may be sold for \$15 to \$30 each, depending on diameter and length.

Production requirements

Given the range of bamboo species and their climatic adaptation, bamboo can be cultivated in most Australian climates, provided that they get enough water. Sympodial clumping species thrive in wet sub-tropical and tropical climates, while monopodial running species are adapted to sub-tropical and cooler climates with a pronounced dry season.



Photo 1. Sizeable shoot of *Dendrocalamus asper*, before harvest in northern NSW.



Photo 2. Established plantation of *Phyllostachys heterocycla* f. *pubescens* near Brisbane showing complete canopy cover.

Nevertheless, availability of water is of overriding importance for effective shoot production. The planting of clumping species in frost-prone areas should be avoided: their foliage is ‘burnt’ by heavy frost and if this is severe it may not grow back.

Well drained soils, of sandy-loam to loamy-clay, are ideal for

bamboo, and although it is well adapted to river bank environments bamboo does not tolerate water-logged soils with a low redox capacity and reputedly does not tolerate salty soils. In Asia bamboo is often cultivated on hillsides, which helps to retard erosion. In seasonally dry sites in Australia, reticulated irrigation permits cultivation on sloping lands.

Table 1. Bamboo species for shoot production, including data on frost tolerance, traditional sites of production and estimated yields from mature plantations.

Species	Traditional production site	Frost tolerance (°C)	Recorded yield (t/ha)
Sympodial			
<i>Dendrocalamus latiflorus</i>	Taiwan, S. China	-4	12-20
<i>Dendrocalamus asper</i>	Thailand	-3	10+
<i>Dendrocalamus giganteus</i>		-4	no data.
<i>Bambusa oldhamii</i>	Taiwan, China	-8	6-12
<i>Gigantochloa atter</i>		-2	nd.
Monopodial			
<i>Phyllostachys heterocycla</i> f. <i>pubescens</i>	N. and C. China, Taiwan, Japan	-15	6-20
<i>Phyllostachys praecox</i>	C. China	no data	no data

If running types are cultivated, it is important to confine their lateral spread beyond the plantation perimeter. A simple vehicular track around the plantation will not suffice to prevent rhizomes from growing beyond the planted area; soil ripping to a depth of 0.5 m may well be necessary. Clumping types are essentially non-invasive, and increase in size by lateral clump-growth only. Some clumping species may, in the case of isolated, unrestricted plants, grow to diameters exceeding 15 m if not maintained, but the norm for cultivated species is 2-3 m.

Species

More than 70 genera and 1200 species of bamboo have been described, but only a handful are grown commercially for their shoots (Table 1). Clumping types have larger shoots (up to 5 kg each) than those of running types (usually not greater than 1.5 kg each) and are harvested when shoots are above ground, in contrast to shoots of running types which are mainly below soil surface at harvest. Because of the nature of plantation growth, it is impractical to enter plantations of running types with vehicles from the second year of growth onwards. Management, especially harvesting, can become more arduous than with clumping types, but access tracks at regular (e.g. 50 m) intervals minimise this disadvantage.

The major features of the prime candidates for shoot production are as follows:

Dendrocalamus latiflorus: 280-400 clumps/ha, mature plantations giving shoots of up to 60 cm in

length and weighing 3–5 kg. Very popular in Taiwan, and large quantities exported to Japan. Performing extremely well in Darwin, and tremendous growth rates at all known production sites in Australia.

Dendrocalamus asper: similar population and yields to *D. latiflorus* but maybe less frost-tolerant. Shoots can reach 30 cm in diameter weighing 4–7 kg, and mature culms 30 m in length. Large-scale production in Thailand with major canned exports to Japan.

Dendrocalamus giganteus: particularly well adapted to Bundaberg conditions. Shoots slightly smaller than abovementioned species, and favoured by Vietnamese. Not yet found in plantations.

Bambusa oldhamii: more frost-tolerant than most clumping species (together with *B. strictus*) but with small diameter shoots (ca 10 cm, Photo 3) and weight (0.5 kg) offset by its good eating quality, and smaller clumps, therefore warranting higher planting density. Slower growing in all trials in Australia than *Dendrocalamus* species.

Gigantochloa atter: also narrow diameter shoots (ca 10 cm), but quite productive and sweet. Not yet found in plantations.

Phyllostachys heterocyclaf. pubescens known as moso in Japan, this is the most widely cultivated species in Japan and N. China, grown mainly for its shoots. Shoots range from 7.5 to 15 cm in diameter, and can weigh on average 1.5 kg, but our experience shows that this size is unlikely until plantations are mature. This may take up to 10–12 years from seed, but less



Photo 3. Sizeable shoots of *Bambusa oldhamii* before harvest at Eumundi. Note: the soil has been removed to expose shoots.

from vegetative propagation. Prolific producer of shoots, with 5–10,000/ha not uncommon.

Other species currently being harvested for shoots from isolated or ‘wild’ bamboo plants in Australia, and marketed, include *P. nigra*, *B. vulgaris* var. *vittata* (from Gympie), *B. balcooa* (from Eumundi) and *B. arnhemica* (from Arnhem Land).

Agronomy

Since fresh bamboo seed is not frequently available in Australia, most bamboo is propagated vegetatively. For clumping species, dividing up existing clumps into one-year-old rooted culms is very effective but gives a low multiplication rate. Cutting culms into sections of one or two nodes (i.e. into pieces of stems, at least 1½ years old, containing one or two rings each with a bud and set of root initials) and placing them upright, horizontally or at an angle, depending on species, in warm, moist conditions in black polyethylene nursery propagation bags is another way

to go. Species vary considerably in their propensity to strike, according to age of culm, position of culm and time of year for propagation. Success rate is currently low, ranging from 20 to 70%, with a high of 90% for *B. oldhamii*. The reader is referred to the author and other contacts for more detailed information on this, and on layering techniques for propagation.

Key statistics

- E Australian imports 6–12,000 tonnes of canned bamboo shoots annually.
- E Japan imports 130,000 tonnes of canned shoots and 3,400 tonnes of fresh shoots annually.

One-year-plus culm cuttings showing shoot activity from the bud, and root development, can

be taken to the field for transplanting into 50 cm \times 50 cm \times 50 cm holes at the desired spacing. Transplanting is best done when it is warm. Because of the high price and lack of supply of planting material, it was recommended, when setting up a clumping plantation, to buy in a number of plants, establish them in the field and undertake one's own propagation. This is a time-consuming process: up to three years before multiplication could be achieved. Nowadays, sources of *in vitro* and vegetatively propagated planting materials are available, reducing the price of planting materials considerably and allowing immediate establishment of plantations.

For running types, rhizome cutting is effective, provided young pieces of rhizome about 50 cm in length are used. An attached young culm may or not be present. The rhizomes should be planted horizontally directly to the field in warm soil to a depth of 10 cm and kept well watered. Experience shows that autumn and especially spring are the best times to propagate running types. The transplanted rhizomes (with or without attached culm) should be spaced on a 6 m \times 6 m square planting, giving a population of 280 plants/ha.

Spacing of clumping types depends on the species, with the smaller structured *B. oldhamii* on 5 m \times 5 m squares (400 plants/ha) and even 4 m \times 4 m, in China, *D. latiflorus* at 6 m \times 6 m (280 plants/ha) and *D. asper* at 7 m \times 7 m (200 plants/ha). These general guidelines will be conditioned by the level of input (water and fertiliser). Fertiliser should initially be applied around the young clump of clumping and

running species, but for the latter, as they extended to cover all space between the original planting positions, fertiliser should be broadcast over all land in the plantation. Some specialised fertiliser practices (e.g. application in a trench 1.5 m beyond the perimeter of the clump) are employed overseas.

Regular light fertiliser is recommended for shallow-rooted bamboo, although twice yearly is more economical of time and is acceptable provided that one application precedes the shoot production period by one month. Our own experience shows little advantage in applying more than a total of 250 kg N: 50 kg P: 140 kg/ha split into two applications for *P. heterocycla* f. *pubescens*, although recommended fertiliser application rates are notoriously specific to soil conditions. Positive response to silicon may also be noted, for bamboo removes sizeable quantities from the soil, especially once culms are removed. A mature bamboo plantation, with annual harvests of shoots and culms (for timber) would remove very approximately 220 kg N: 31 kg P: 200 kg K/ha each year largely as timber, and this should be replenished by way of organic and inorganic nutrient sources.

Bamboo shoots comprise 90% water, and adequate water supply to plants during the shoot production is crucial for high shoot yields. Our data suggest that soil moisture tension should not drop below 20 kPa while shoots are emerging, but further research is necessary to understand bamboo's water requirements out of the shoot-production phase. Microsprinklers adjacent to

young clumping types, and later minisprinklers for older clumps (two years plus) and in running plantations, are effective in spatial supply of water to bamboo. A good leaf mulch develops in running type plantations, and additional mulch is added to ensure that sprouts of running types, especially the early harvested ones, are not exposed to light. Soil or compost may be sparingly heaped up to the centre of bamboo clumps to encourage shoot growth since new buds are always higher than the point of insertion of previous years' rhizomes.

Key messages

- E A plentiful supply for water (rainfall/irrigation) is essential before and during the shoot season, and plantations should not be established if this cannot be guaranteed.
- E A labour-intensive crop, especially during the shoot season for harvest and culling of culms.
- E Most bamboo stock in Australia is unlikely to flower in the next few decades.

Bamboo produces numerous culms, and in the early establishment years the thinnest culms should be removed, for there is apparently a positive relationship between diameter of standing culms and diameter of the next season's shoots. Indeed, from year to year the diameter of shoots increases until full canopy cover. As full canopy is achieved, weeds are smothered, but during

establishment they must be kept under control by slashing. Much care is necessary not to decapitate young shoots while brush-cutting.

Approximately 1500–2000 culms are common for mature running-type plantations, leaving about 300 shoots/ha each year for new culms, and culling out the same number of oldest culms. From 6 to 10 culms are present per clump in mature clumping types, ranging in age from one to four years. One to three large shoots are left each year for new culms, with culling of the same number of old culms.

Pests and diseases

Very few pests and diseases have been recorded in bamboo in Australia. A waxy scale insect is known to grow on bamboo culms, but the influence on yield is unknown. A leaf-rolling caterpillar (*Crocidophora pustuliferalis*) also colonised various bamboo species, especially *B. oldhamii*, in young plantations at Darwin. *D. latiflorus* was less susceptible, most likely as a factor of its larger leaf size. Bamboo in Australia so far has not been colonised by the insects reported to attack it elsewhere (e.g. bamboo aphid, cutworm, mites). To date bamboo in Australia is free of the diseases (e.g., bamboo mosaic virus, sugarcane mosaic virus, rusts such as *Puccinia phyllostachydis*) known to infect it overseas.

Harvesting and marketing

Shoots are manually harvested by digging around the base of the shoot, to a depth of 15 to 60 cm for running types, and close beneath the soil surface for

clumping types. The shoots are cut at the transition between soft shoot tissue and fibrous rhizome, and should be stored at temperatures close to 1°C in forced air-cooling before marketing. Special narrow sharpened spades are used for harvesting running types, as are custom-made heavy duty hoe-type knives for the clumping species. However, local variations within Asia may occur, for example sharpened hoes are used for harvest of *P. heterocyclus* f. *pubescens*, a running type, in Anji County in China. Shoots are currently packed in 10 kg polystyrene boxes and marketed fresh—postharvest practices are quite rudimentary in Australia and research is lacking. Cold chains will be essential for a successful industry. In Asian wet markets, bamboo shoots are stored in water, after the outer sheath has been removed, and sold on demand for direct food preparation.

Economics of production

Table 2 details expected costs for setting up one hectare of bamboo for shoot production. Costs for planting material of clumping species may drop to one half of current price as tissue-culture derived plants enter the market. Annual labour for weeding and thinning, fertiliser application and irrigation, is high at establishment, but declines to less than one half after plantation maturity.

Small shoot harvests of most bamboo will begin two to three years after transplanting, and it is important to remove shoots, especially the small diameter ones, either for sale or as culled materials, so that the culm population does not rise excessively above that mentioned earlier.

Table 2. Set-up, ongoing costs, and returns for 1.0 ha bamboo plantation for shoot production.

Fixed costs	\$
Land preparation	450
Planting	500
Irrigation	3500
Plant material ^a	6000–9500
Cold storage	Optional
Variable costs	\$
Annual inputs	1800
Annual labour ^b	8000
Harvesting ^c	12 cents/kg
Returns	
Yields ^d (marketable) 6–12 t/ha @ \$3.00/kg	\$18–36,000

^a For *D. asper* 200 plants @ \$30/plant
 For *P. heterocyclus* f. *pubescens* 625 plants @ \$15/plant
 For *D. latiflorus* 270 plants @ \$30/plant

^b Declining to 50% by plantation maturity

^c Higher costs for running species, and harvest in immature plantations.

^d At least five to eight years for complete yields, partial yields from two to four years.

Plantations will mature from 7 to 10 years after planting, giving yields in the range mentioned in Table 1.

By the end of 1997 it is estimated, through analysis of nursery sales and through surveys, that 50 ha of bamboo will have been planted in Australia, with production (once plantations are mature) sufficient to satisfy approximately one fifth of the local market during the shoot season. Overseas markets (Table 3), especially in Taiwan and Japan, must be sourced immediately to absorb production additional to the future needs of the Australian market. Postharvest research on semi-processing will aid in extending the local availability of fresh shoots, as will agronomy and species adaptation trials aimed at hastening or delaying harvest. Air freight costs of approximately \$2.50/kg to N. Asia must be taken into account when assessing the fresh market option in that region, as must import tariffs raised by some countries.

Flowering

Many bamboo species flower gregariously; that is, a clone of a

species will flower uniformly across regions, and even countries, in response to an unknown stimulus. Depending upon species, this gregarious flowering may span cycles of from a few decades to more than a century. As the species flowers, all culms will produce inflorescences and then die, leaving at the worst a ghost plantation without living bamboo. Propagation of species from the seed of accessions of species known to have flowered recently will reduce the risk for short to medium term flowering, but the issue is as yet incompletely understood. Gregarious flowering is preceded by a reduction or cessation of shoot formation in the previous seasons. Where not truly gregarious, this might reflect severe drought stress. Removal of the first flowering stems, and heavy application of nitrogen fertiliser can reputedly stem flowering, but we have no experience of this practice. *P. heterocycla* f. *pubescens* reputedly has a 70-year flowering cycle, and local plants in Australia derived from seed introduced in the late 1980s will be expected to flower in the middle of the next century. *D. asper* has a similar flowering cycle, and some sources of

planting material are derived from a flowering event in Thailand in the early 1990s, giving some assurance that the next bout of flowering will also not occur before 2050.

Key contacts

Professor David Midmore
Biology Department
Central Queensland University
Rockhampton, Qld 4702
Phone: (07) 4930 6870
Fax: (07) 4930 9209

Australian Bamboo Network
P.O. Box 174
Fremantle, WA 6160
<http://www.ctl.com.au/abn/abn.htm>.

Bamboo Internet Group – Send message ‘subscribe bamboo’ to: Maiser@housing.ucsc.edu.

Victor Cusack
Bamboo World
Murwillumbah Road
Wadeville, NSW 2474
<http://www.nrg.com.au/bamboo>

Durnford Dart
Bamboo Australia
MS 1330
Kenilworth Road

Table 3. Estimated annual figures (t) for bamboo shoot production and consumption

Country	Domestic production		Import		Export	
	Canned	Fresh	Canned	Fresh/frozen	Canned	Fresh
Australia	0	Negligible	6-12,000	0	0	0
Japan	30,000	50,000	130,000	3,400	0	0
Taiwan	330,000 ^a		0	0	40,000	1000
China	1,600,000		0	0	140,000 ^b	6000
Thailand	nd.	nd.	0	0	70,000	nd.
USA	0	0	nd.	7,000 ^c	0	0

^a Estimated from 33,000 hectares of plantations.

^b Does not include moso

^c Includes Chinese waterchestnut

Belli Park via Eumundi, Qld 4562
<http://www.bamboo-oz.com.au/>

Hans Erken
Earthcare Enterprises
P.O. Box 500
Maleny, Qld 4552
Email: earthcare@peg.apc.org.

Obaki Bamboo Bookshop
P.O. Box 238
Donnybrook, WA 6239

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