The Coconut Palm—Its Place and Potential in Australia

Prepared by Mike Foale

Mike Foale

Honorary Research Consultant,

School of Agriculture and Food Sciences,

University of Queensland,

St Lucia , Qld, 4067, Australia.

P: +61 7 3365 1111

F: +61 7 3365 1177

E: m.foale@uq.edu.au

Mike Foale MAgrSc (Adel), DTA (Trinidad) FAIAST, is a former Principal Research Scientist with CSIRO Sustainable Ecosystems and consultant to ACIAR. From Adelaide University Mike attended British Colonial Service training at Cambridge University and the Imperial College of Tropical Agriculture in Trinidad before taking up a post as Agronomist in a Joint Coconut Research Scheme on the Unilever Plantation at Yandina, British Solomon Islands (1959 to 1968). He joined CSIRO in 1969 working in tobacco and sorghum agronomy, and then in the Agricultural Production Systems Research Unit in Toowoomba until retirement in 1998. Mike was seconded part-time to ACIAR during the 1980s and early 1990s as consultant to its coconut research projects addressing diseases and improvement in productivity. He reviewed in 1996 and 2001 the Coconut Genetic Resources Network of Bioversity International (formerly IPGRI).

Abstract

Prior to European settlement the coconut (except in Torres Strait) was known to indigenous Australians only from the drifted fruit that they collected for food on northern beaches. Although it had naturally colonised tropical coasts and islands over millions of years, and had been embraced for millennia by human settlers as a staple food, it was but a novelty to mainland Australians. From its present status as principally an ornamental in tropical coastal towns and resorts its potential to become a worthwhile niche crop deserves attention. Coconut oil from the developing world lost its status as the dominant edible vegetable oil in world trade as other oils competed successfully for its markets in the late 20th century. Having survived their commercial onslaught, in which it had been asserted that coconut was a health risk, it is now poised to regain a high status in Western diets.

There are commercially positive directions in which to develop a coconut production base in Australia, as a mono-crop as well as a companion crop, for example in the northern sugar-lands. Australian coconut research experience through ACIAR has built a small body of expertise to support the expansion of coconut production in Australia along with a likely benefit to coconut producers in neighbouring countries through the growth in our market.

Introduction

Apart from two well-documented occurrences of "pre-settlement" palms (McGillivray 1852; Thozet 1869; Dowe and Smith 2002) and the comment of Mueller (1867): *on a few spots of the coast the Cocoanut-tree occurs spontaneously*, the coconut as a crop was unknown to early settlers. Early in the 20th century there was a brief period of interest (Cowley 1898) and investment in coconut in Australia (e.g., McClaren 1926), and by Australians in Melanesia (Bennett 1987), responding to the high price for coconut oil paid by Lever Brothers in Sydney. Many decades earlier (1827) coconut export to England was initiated from the Cocos Keeling islands, an "unflagged" territory at the time—since 1978 an Australian External Territory (Leach et al 2003). Demand for coconut oil had ascended as the supply of whale oil fell (Tonnessen and Johnsen 1982) in the late 19th Century to the point that William Lever stated : *I know of no field of Tropical Agriculture that is so promising at the present moment as coco-nut planting, and I do not think in the whole world there is promise of so lucrative an investment of time and money as in this industry* (Lever 1912). There followed solid investment in coconut plantations reaching about 1 million ha in area by 1930 (Menon and Pandalai 1958; Child 1964).

Coconut oil became important in trade and commerce from 1880 when its rise began due to dietary preference over animal fats (tallow, whale oil and others), and was boosted by the invention of margarine around 1908. It remained important in trade until the 1960s when a suite of other vegetable oils, especially soy and later canola and palm oil, achieved dominance. Coconut now supplies less than 5% of vegetable oil traded while sustaining its position as a key ingredient in the diet of tropical peoples world-wide. Before considering the potential commercial role of the coconut in Australia it may be useful now to consider its evolutionary background to gain an insight into the unique attributes of this plant.

The high energy density of the coconut kernel, which provides extended support to the growth of the seedling, also underpins its popularity as a food.

Botanical origins

The coconut palm evidently emerged on the shores of one or more of the drifting Gondwana land fragments (Harries 1978, 1990) and evolved an increasingly large and "seaworthy" seed enabling dispersal between the several coasts dispersing across the Tethys Sea (Foale 2003). The modern coconut seed has the ability to remain viable while traversing oceans for periods up to 120 days, and to provide sole nourishment to the seedling for four months and further nutrition for another 12 months once a suitable strand location has been reached (Foale 1968). This long-lasting nutrient supply, from its very large liquid and solid endosperms, the latter comprising 33% oil and a fresh weight of 200 g, enables successful colonisation of strands and river deltas. Roots extend rapidly to the water table as the shoot emerges through the husk and the first leaf unfolds.

One result of the multisite evolution of the coconut on the moving "rafts" of land dispersing from Gondwana was that different populations were exposed to assaults from quite diverse pathogens and insect fauna, as the adjacent ecosystems ranged from dense rainforest to the sparse vegetation of some coral atolls and islands. As a consequence the transplanting of genetic material in modern times has often resulted in populations succumbing to the attack of unfamiliar organisms which had played no part in their evolution that had been in the company of different biota. The high failure rate of a dwarf by tall hybrid taken from West Africa to Indonesia, where it succumbed to the local strain of *Phytophthera palmivora*, and the fierce assault by the *Scapanes* rhinoceros beetle in PNG of the dwarf by Rennell tall hybrid from Solomon Islands are well-known, but not unique, examples of this.

Domestication

The "wild-type" coconut with its thick husk would have been a welcome bounty for the first human populations colonising the coasts and islands of the humid tropics. Unsurprisingly, as the coconut fruit was such a convenient source of food and drink, larger seeds with a lower proportion of husk were selected for expanding or renewing coconut groves. Early European navigators quickly adopted coconut fruit as a bonus supplement to the unattractive preserved supplies normally carried. James Cook and Joseph Banks sought eagerly for signs of coconut palms while travelling north along the east coast of Australia in 1770 and were disappointed that palms seen from a distance on Palm Island (off the Queensland coast) turned out to be a *Livistona* species (Dowe and Smith 2002).

The high energy density of the coconut kernel, which provides extended support to the growth of the seedling, also underpins its popularity as a food. Not only does the fresh kernel contain 33% by weight of oil, but two-thirds of the fatty acids in that oil are of the medium-chain type, shown later to be conducive to good health.

Coconut in modern Australia

In Australia, the coconut palm is known to the general community as a graceful ornamental, adorning beaches, streetscapes and tourist resorts of the humid tropics. However, it also attracts the nervous attention of local government and resort managers seeking to avoid injury to visitors by removing developing fruit which might fall. There was only a very small number of coconut palms on the tropical coast prior to colonial settlement (Foale 2003; Dowe and Smith 2002) and no coconut tradition, except strand collecting of drifted fruit, among mainland indigenous people in tropical Australia. On the other hand, Torres Strait islanders share the Melanesian tradition of coconut planting and regular household use of coconut water and cream.

Beside the limited missionary planting of coconut for direct consumption (eg at Mapoon and Hopevale on Cape York Peninsula) and planting by a few investors responding to government enthusiasm (Cowley 1898)—near the tip of Cape York (McLaren 1926), Wonga Beach near Mossman, and Bramston Beach near Innisfail, there was limited domestic planting in northern settlements. High labour cost relative to that available on colonial plantations stifled any significant commercial development within Australia.

Copra and coconut oil

Copra was imported into Sydney by Lever and Kitchen from their own plantations (Levers Pacific Plantations Pty Ltd) and others in the Solomon Islands and elsewhere. Levers operated a coconut oil mill at Balmain where processing continues to this day, although they disposed of the last of their plantations in the 1990s to concentrate on oil palm plantations elsewhere. The copra-derived oil, after being refined, bleached and deodorised, was used in soap manufacture, and was popular as a frying oil, as shortening in recipes for cakes and biscuits, and in an hydrogenated derivative with a high melting point, known as Copha. Imported fresh coconuts were a notable novelty in some fruit shops and super-markets, while desiccated coconut has long been popular with the general population for many types of cakes, especially lamingtons and macaroons. However, in recent decades migration from Asia and the south Pacific, and the increasing popularity of "Asian cuisine" have led to the increased use of coconut oil and coconut cream.

A dilemma has arisen for coconut because, following the boom in demand in the West from 1880 to 1960, interest in coconut oil declined steadily over the next several decades as it experienced growing competition from expanding production of other edible oils (eg soy, canola, palm, palm-kernel and cotton-seed). These competitors, with the exception of palm-kernel oil, all possess quite different chemical properties and dietary effects from coconut oil.

Oil chemistry

Vegetable oils comprise cocktails of diverse fatty acids, separated into categories related to chemical structure and consequent physical properties. The principal fatty acids from plant sources that are of most interest in human and animal nutrition are grouped into three main categories: saturated – of which there are six; mono-unsaturated – of which there are two; and poly-unsaturated of which there are four of particular interest (Table 1 - derived from Enig 2000).

Two of the listed poly-unsaturated acids are described as "essential" to health due to the inability of mammal lipid physiology to generate them. These are linoleic acid ("omega 6") and alpha linolenic acid ("omega 3"). There are two other omega 3 fatty acids (EPA and DHA) that are generated from alpha-linolenic by enzymic elongation. This conversion proceeds rather poorly in mammals, but very effectively in algae-consuming fish. The key research upon which the soy industry mounted its campaign against coconut oil involved comparing a soy diet in which the essential fatty acids were naturally present (see Table 1) with the coconut oil diet from which they were absent. The soy oil diet supported healthy animal growth while the deficient coconut diet did not, and total plasma cholesterol rose (Hegsted et al 1965). As a consequence, the theory that all saturated fats pose a significant risk to heart health was given high initial credibility, which suited coconut oil competitors very well.

Table 1. Fatty acids in the "cocktail mix" of different natural oil extracts (%).

The acid name and numbers respectively of Carbon atoms (x) and double bonds (y) are shown thus - x:y – at the top of each column

Source of oil	Caprylic-8	Capric-10	Lauric-12	Myristic-14	Palmitic-16	Stearic-18	Palmitoleic 16:1	Oleic-18:1	Linoleic-18:2	αLinolenic 18:3	Others
Coconut	8	7	49	18	8	2	-	6	2	-	-
Palm k(1)	4	4	50	16	8	2	-	14	2	-	-
Palm	-	-	-	1	45	5	-	39	9	-	-
Soy	-	-	-	-	11	4	-	23	53	8	-
Olive	-	-	-	-	14	2	1	71	10	1	-
Canola(2)	-	-	-	-	4	2	-	59	23	10	2
Butter	1	2	3	12	26	12	2	28	3	1	8(10)
Tallow	-	-	-	3	25	22	3	39	2	1	2
Cod liver	-	-	-	4	14	3	12	22	1	-	44(11)

NOTES: 1. Palm kernel; 2. Regular canola; 10. includes 4% butyric; 11. includes 7% each of EPA (eicosapentaenoic—5 double bonds) and DHA (docosahexaenoic—6 double bonds)

Data from the book "Know your fats—the complete primer for understanding the nutrition of fats, oils and cholesterol" by Mary Enig (Bethesda Press, 2000. Silver Spring, Maryland).

The distribution of fatty acids among the many edible products listed in Table 1 shows that coconut oil stands out (alongside palm-kernel oil) with its preponderance of shorter "medium chain" fatty acid molecules – those with 8, 10 and 12 carbon atoms. The distinction between these and saturated molecules with 14 and 16 carbon atoms has taken on great significance because the marketers of soy oil in particular presented coconut oil as a heart risk because there is a proven link between some saturated fatty acids and a rise in plasma LDL (low density lipo-protein) in otherwise healthy individuals. In recent decades, however, it has been shown that medium chain saturated fatty acids actually raise HDL (high density lipoprotein – a natural antidote for LDL), and in the case or lauric acid the rise in HDL is more than for LDL, thus reducing the risk to heart health. This is reported on the website of the Australian Heart Foundation (2011) as follows:*Lauric, myristic and palmitic acids are associated with an increase in HDL-C compared to CHO. Lauric acid increase of HDL-C is greater than other individual SFAs.*) Note: *CHO is carbohydrate.* Coconut oil contains around 50% lauric acid (Table 1).

The negative messages about coconut oil that were disseminated by many health professionals, influenced by the campaign to link all saturated fats to heart disease, are now seen to be misleading. There has thus far been an unfortunate lack of interest in adding potentially health-giving locally-available coconut products (fresh kernel, coconut cream and oil) to the diet of indigenous Australians on our tropical coasts. This is particularly topical because of the recent finding that coconut oil alleviated the symptoms of Type 2 diabetes (rife in communities where the diet is dominated by high carbohydrate food and drink) in laboratory studies in which the medium-chain fatty acids of coconut oil *may therefore be beneficial for preventing obesity and peripheral insulin resistance.* (Turner et al 2009).

Potential for local production

Among a few small investors there is a stirring of interest in coconut planting in the humid tropics. They are hoping particularly to profit from rising interest in both coconut oil and water. The promotion of coconut water from immature fruit as both a health drink (Fife 2010) and a sports drink has raised its market profile in many Western countries including Australia. Rising market value due to a combination of interest in coconut drink and coconut oil as health products could, in the near future, provide the foundation for profitable small-scale coconut production in Australia. Foale and Roebeling (2006) proposed coconut as a companion crop for sugar-cane in north Queensland, as well as being potentially highly productive in coastal environments as a monocrop. Rapid supply from north Queensland to urban markets would raise the quality and consumer acceptance of fresh coconut products adversely affected by the present long delays involved with imports by sea from distant suppliers in south-east Asia and the south Pacific.

Investment in the importation of new coconut genetic variants requires a long lead time as the embryo culture and nursery stages of seedling development occupy 18 months between germination and field planting, compared to 10 months when raised from a seed-nut. The first fruit (seed), even from a precocious Dwarf population, would not be available for another five years. It is unlikely that the coconut would become a major crop in Australia due to a combination of limited potential areas for planting and their remoteness from suitable markets. **However, because of the recent rebuttal of the claims by competing oil marketers that coconut oil is a health risk (Fife 2005) the fruit of the coconut is too valuable to be left to languish as a disappointing import.**

There is already some small-scale enterprise supplying both immature fruit ("tender nuts") for coconut water, and fresh mature fruit, priced between $3 and $5 per unit, to local markets in the Queensland and NT tropics, and to outlets on the east coast as far south as Sydney. Increased supply would meet not only the casual demand from tourists but growing demand from local populations, both settler and indigenous. The demand for coconut water stems from its growing popularity as a "sports drink" and also its reputation for several specific health benefits (Fife 2010; Turner et al 2009). Coconut oil in the diet has been reported to have a profoundly favourable effect on general health (Fife 2008).

The prospect for profitable investment in coconut production in a monoculture setting, or as a companion crop in sugar lands for example (Foale and Roebeling 2006), appears to be very interesting in north Queensland in particular, on the basis of fresh fruit valued around $3 to $5 per unit at the retail level. Production from well-managed palms would begin around 6 years. From the tenth year, for a period of 30 years, it might average between 10 000 and 20 000 units per hectare, depending on fruit size and good plant nutrition. Palms producing mature fruit would yield at the lower end of the range. Harvesting of immature fruit for the coconut-water market avoids the considerable investment of biomass needed between that stage and maturity, thus enabling an increase in the number of fruit carried. Tender nuts require labour-intensive direct harvesting from the palm whereas mature fruit may be gathered after falling naturally.

Even though forms of coconut water, either residing undisturbed in the whole fruit or canned or "tetra-packed"—sometimes with added sugar and preservative, are currently imported into Australia, there would undoubtedly be increased demand for coconut water produced locally because of its greater "freshness". Besides ordinary coconut water there are some attractively-aromatic variant forms which have greater market value. Another rare form possesses a soft, somewhat creamy kernel, occupying most of the vacuole. Known as Makapuno in Philippines, Kopyor in Indonesia and Garuk in PNG, these forms would attract a price premium up to $10 per fruit. Embryo culture, first developed in the Philippines and recently refined at the University of Queensland (Samosir et al 2008), could be key to their establishment if these unique forms can be imported. Laboratory-based technology for somatic embryogenesis at the University of Queensland (Antonova 2009) would, with further investment in its efficiency, enable rapid multiplication of these commercially very attractive forms.

The many other coconut products already mentioned are less attractive commercially in the Australian context because of the much higher local labour cost compared to coconut heartland regions like Melanesia, Indonesia, Philippines and the rest. Comprehensive processing of mature fruit could generate some of the following suite of products:

- kernel, that may be separated into oil and residue rich in edible fibre and protein suitable for animal feed or to be ground into flour, or shredded fresh to become desiccated coconut;
- shell, that may be ground finely into a useful lubricating powder, used unprocessed as fuel, or converted to charcoal and activated carbon, or for limited processing into bowls and curios;
- husk, that may be separated into fibre, and cortex or "cocopeat".

Value adding to coconut fibre takes the path of rubberising for mattresses and upholstery, or conversion to yarn for incorporation into robust ropes, or assembling into diverse nets known as geo-textiles that are employed in landscape protection. The heartland countries are exporting increasing quantities of fibre derivatives to meet growing demand for stabilisation of disturbed soil and protection of erosion-prone landscapes, especially in China. All these processes are labour-intensive and unlikely to be undertaken in Australia except on the scale of a cottage industry. There is great potential for value-adding to coconut oil, be it for food use in the form of coconut cream (the emulsion extracted from the kernel), cooking oil or as a butter substitute in recipes, or direct consumption as a "nutriceutical", and in a powdered form giving excellent results in the diet of monogastric animals (Kempton—personal communication). Esterified coconut oil can substitute fully for diesel or find use as an additive where the price dictates, while raw oil has been successfully blended with diesel fuel (Cloin 2006).

Engaging Australian expertise

If the attractiveness of the coconut as a source of food and drink results in sufficient growth in demand and price to stimulate significant investment in new and replacement plantings, the experience of Australian institutions could be drawn upon to assist. For thirty years the Australian Centre for International Agricultural Research has funded projects investigating coconut diseases and genetic resources (Samosir, Foale and Adkins 2006), timber and supply chain development in the South Pacific. The outcome of one project (Hanold and Randles 1993) is that viroid and virus diseases have been identified, and quarantine protocols to guard against the accidental introduction of such diseases (notably viroid-induced *cadang cadang* and virus-induced *foliar decay*) have been devised.

ACIAR also undertook in 1985 a Coconut Improvement Project that had the objectives of surveying the genetic resources invested in coconut production in the South Pacific (particularly PNG and the rest of Melanesia) and identifying possibilities for germ-plasm exchange and genetic improvement. In 1991 ACIAR supported the formation of COGENT (Coconut Genetic Resources agency), of Bioversity International (then known as the International Plant Genetic Resources Institute – IPGRI—within the Consultative Group for International Agricultural Research of the World Bank) and funded surveys of coconut genetic resources in the South Pacific that were complemented by the work of others globally (Persley 1992). The Coconut *Genetic Resources Database* (2011) was compiled by French researchers to provide readily accessible output of characterisation and evaluation data for coconut populations, and has become a comprehensive global resource for the coconut industry (Web Ref 1 2011). COGENT and other agencies (eg CIRAD of France) have supported basic research into the genetic diversity of coconut world-wide (Gunn et al 2011), and experience with the use of hybrids, leading to a greater understanding of the limitations to productivity (Adkins, Foale and Harries 2010; Foale and Harries 2011). While the coconut produces a range of valuable commodities including fibre and cocopeat or cortex from the husk, plus shell, oil, kernel residue and coconut water, aspirations to compete with oil palm on the basis of oil production alone have proved to be futile (EOLSS 2010).

ACIAR has also supported in-depth work on embryo culture of coconut, a procedure of particular importance in the movement of germ-plasm, as most coconut seeds weigh in excess of 1 kg. The outcome of this work was a universally-available guide to embryo culture (Samosir et al 2008) prepared by researchers at the University of Queensland. In addition there has been a successful ACIAR-funded project on somatic embryogenesis, and University of Queensland and AusAID support for work on cryopreservation of the coconut embryo. These outcomes would enable the multiplication as well as the preservation of specific valuable genetic material (Antonova 2008; Sisunandar 2010). ACIAR has also supported research and development for wood products derived from the trunk of aged coconut palms in the South Pacific.

An Australian company, Kokonut Pacific Pty Ltd, has developed a mechanical process for the separation of coconut oil known as Direct Micro-Expelling, that has been successfully established in the coconut world, especially Solomon Island and Melanesia. This technology has the potential to contribute to production of virgin coconut oil (oil not subjected to high temperature) in small-scale production centres in Australia (Etherington 2006).

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