

14 Plantation Crops

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Introduction

Plantation crops are high value commercial crops providing food and oil (coconut and oil palm), beverages (coffee, cocoa and tea), masticatory (arecanut and kola), dry fruits (cashew) and industrial products (rubber); and some of them form ingredients in Ayurvedic medicine. Since they flourish well in tropics between 20°N and 20°S of equator, India has a special climatic advantage in plantation crops cultivation and industry. While many of these crops like coconut, arecanut, pepper etc. are cultivated in India from time immemorial, a number of others like rubber, cocoa and oil palm were introduced into the country by travelers, colonialists, traders and technicians and have found a happy home herein. Coffee, tea, coconut, arecanut and cocoa are important plantation crops in India, they are cultivated in all the southern states, northeastern states, Andaman Nicobar islands, Lakshadweep islands and other states like Maharashtra, Gujarat, Orissa and West Bengal. Coconut, arecanut and cocoa provide livelihood to many farmers in these states. They are adapted to tropical climate and are perennial in nature. Cocoa is cultivated as an intercrop in coconut and arecanut gardens. Research and development in these crops are confronted with many challenges. Many technologies have been developed over the years to meet the challenges. There are many indigenous knowledge that passed through generations and stood the test of time. In the present era of intellectual property rights, it is important to know the opportunities thrown up by the new regime of patents and plant variety protection.

Production

Coffee

The importance of coffee in the world economy cannot be overstated. It is one of the most valuable primary products in world trade, in many years second in value only to oil as a source of foreign exchange to developing countries. Its cultivation, processing, trading, transportation and marketing provide employment for millions of people worldwide. Coffee is crucial to the economies and politics of many developing

countries; for many of the world's least developed countries, exports of coffee account for a substantial part of their foreign exchange earnings in some cases over 80%. Coffee is a traded commodity on major futures and commodity exchanges, most importantly in London and New York.

More than 50 countries in the tropical and sub-tropical regions of Latin America, Africa and Asia are involved in coffee production. The two most important species of coffee economically are *Coffea arabica* (Arabica coffee)—which accounts for over 70% of world production—and *Coffea canephora* (Robusta coffee). Two other species which are grown on a much smaller scale are *Coffea liberica* (Liberica coffee) and *Coffea dewevrei* (Excelsa coffee). World coffee production shows large annual fluctuation. According to International Coffee Organization (ICO), coffee production in the crop year 2003-04 was 101.3 million bags (60 kg bags). In India, coffee is cultivated mainly in the southern states of Karnataka (57.5 %), Kerala (23.8 %) and Tamil Nadu (8.6 %), which forms the traditional tracts.

Tea

Tea (*Camellia sinensis* (L.) O.Kuntze) belongs to family Theaceae. Tea drinking originated in China where it was consumed as a medicinal drink as early as 3000 BC. Tea is the cheapest hot beverage at present and it is consumed by two thirds of the world's population. The global production of tea was about 3097 million kg (in 2003) and three major countries viz., India, Sri Lanka and China together contributed about 60 percent of the global production followed by Kenya, Indonesia and other countries in Africa. India is the largest producer and consumer of tea in the world. It is grown in about 0.44 million ha. in the states of Arunachal Pradesh, Assam, Manipur, Nagaland, Tripura, Sikkim, Uttaranchal, Himachal Pradesh, Bihar, West Bengal, Orissa, Karnataka, Tamil Nadu and Kerala. The total production of tea in India was about 906.84 (2004-05) million kg from 5.21 lakh ha., and about 205 million kg is exported which contributes over 7 per cent of gross earnings in foreign exchange (Anon, 2007). In India, there are three distinctly different tea growing regions. These regions are geographically separated, thereby producing three entirely different teas both in style and in taste/flavor. The three regions are Darjeeling (North-Eastern India), Assam (North-East India) and Nilgiri (South India).

Coconut

Coconut is integral part of people's life and culture wherever it is cultivated and it is rightly called as tree of life. Though mainly cultivated for oil, there are 300 products useful to man that includes food, drink, fuel, livestock feed, fibre and building materials. The natural health drink, tender coconut, is slowly making inroads in to the world soft drink market. Coir, the natural fibre from coconut, is an important product that is finding many uses in the modern world. Now coconut oil is

considered second only to mother's milk in having monolaurin. Monolaurin (Lauricidin) has found use in cosmetic, pharmaceuticals and in clinical medicine. Monolaurin as a dietary supplement has shown extraordinary results as an antibiotic and as an antiviral agent.

Worldwide, coconut is cultivated in 92 countries on about 12 million ha. and 50 millions of people depend on this crop for their livelihood. Ten major countries producing coconut and their contribution to the world production is given in the table 1.

Table 1. Percentage of world production

1. Philippines (30%)	6. Thailand (3%)
2. Indonesia (26%)	7. Mexico (2%)
3. India (18%)	8. Vietnam (2%)
4. Brazil (5%)	9. Malaysia (1%)
5. Sri Lanka (3%)	10. Papua New Guinea (1%)

Coconut palm was first grown as a plantation crop in the second half of 19th century. In the 19th century when the industrial process for making soap required a cheap source of oil, coconut oil provided it. Then the development of dynamite put a great demand on glycerine, a byproduct of soap manufacture. As a result, coconut plantations were established throughout the tropics. In the 20th century, by the end of Second World War, coconut oil had lost its sheen due to the arrival of other oils like soya, palm oil and cottonseed oil. Industrially, petroleum-based detergents and synthetic fibre ousted coconut oil and coir. The 21st century is witnessing re-emergence of coconut as the source of healthy cooking oil, natural health drink and geotextile.

In India, coconut is cultivated in 1.8 million ha. with an annual production of 12,597 million nuts. It is cultivated mainly in the states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, Assam, West Bengal, Pondicherry, Gujarat, Goa and Maharashtra and in the islands of Lakshadweep, Andaman and Nicobar. Recently, coconut cultivation has also been introduced to suitable locations in non-traditional states like Madhya Pradesh, Rajasthan, Bihar, Tripura, Manipur and Arunachal Pradesh.

Arecanut

Arecanut, *Areca catechu* L., is an important crop with a prominent role in the social, cultural and economic activities in India. It is estimated that more than ten million people depend on arecanut for their livelihood in India. World production of arecanut is about 0.610 million tonnes from an area of 0.476 million hectares. The major arecanut growing countries in the world are India, Sri Lanka, Bangladesh,

Malaysia, Indonesia and Philippines. The current world productivity is 1.287 t/ha. China has the highest arecanut productivity with 3.752 t/ha. India ranks first in both area and production. In India, production is about 3,34,000 tonnes from an area of 269 thousand hectares. In the last four decades, productivity has increased from 845 kg/ha to 1243kg/ha. Karnataka, Kerala, West Bengal, Assam and Tamil Nadu are the important states producing arecanut. Andhra Pradesh, Goa, Maharashtra, Meghalaya, Mizoram, Nagaland, Tripura, Andaman & Nicobar Islands and Pondicherry are other states and union territories growing arecanut.

Consumption of arecanut in the country increased to 0.336 from 0.114 million tonnes in a fifty year period from 1950. The projected demand of arecanut by 2020 is about 0.617 million tonnes. A small quantity, about 1502 tonnes, of processed arecanut in the form of panmasala, scented supari and gutka are exported.

Cocoa

Cocoa (*Theobroma cacao* L.) is a much recent introduction to India. It was only in the early years of 20th century that the cocoa cultivation was started in India. *Theobroma cacao* is a native of Amazon region in South America. It was known and used by the natives in this region and was considered as the “food of the gods”. The cocoa press was developed during early 17th century for the extraction of cocoa butter. In the later half of 17th century, the Swiss developed both milk chocolate and solid chocolate. The genus *Theobroma* has more than 20 species, but only *Theobroma cacao* is cultivated widely. There are three major varietal groups, namely, Criollo, Forestero and Trinitario. Forestero is the one that is commercially grown all over the world. It is high yielding more resistant to pest and diseases and more tolerant to drought. Criollo produces fine and flavour beans. Trinitario variety is a cross from Criollo and Forastero. Tropical countries in the African continent are the major producers of cocoa. World production is about 30 lakh MT. Côte d’Ivoire, Ghana, Indonesia, Nigeria, Cameroon, Brazil, Ecuador and Malaysia are the major producers. These countries represent 90% of world production. India contributes only 10 thousand MT from an area of 27 thousand hectares.

In India, cocoa is cultivated as a mixed crop in the coconut and arecanut gardens. Though it comes under plantation crop, pure plantations of cocoa are rarely found in India. Commercial cultivation of cocoa was started in 1960s. Cocoa beans are the raw material for confectioneries, beverages, chocolates and other edible products. Kerala and Karnataka were the leading States in cocoa cultivation. Cocoa adapted well to the coconut and arecanut gardens of these states. In recent years, cocoa cultivation was started in states like Tamil Nadu and Andhra Pradesh.

Cocoa has been known as the beverage crop even before tea or coffee. Today, cocoa bean is the major raw material for confectionery industries.

Rubber

The Para rubber tree of commerce, *Hevea brasiliensis* (Will des. ADR de Juss.) Muell. Arg is the most important source of natural rubber, and meets around 98 per cent of the global requirement. Rubber is cultivated mainly in the tropical regions of Asia (Malaysia, Indonesia, India, Sri Lanka, China, the Philippines and Vietnam), Africa (Nigeria, Cameroon, Ivory Coast and Ghana), and America (Brazil and Mexico). In the world scenario, Thailand is the largest producer of natural rubber followed by Indonesia and Malaysia. India is the fourth largest producer and consumer of natural rubber in the world. India's production is 0.51 million ha.

Uses

Coffee

Coffee is primarily used as a stimulating beverage with characteristic organoleptic properties. Coffee is also used to impart its characteristic flavour to other food ingredients like cakes, chocolates etc. Schilter *et al.* (2001) have given an overview of the health and safety considerations of coffee consumption. The chemical constituents of coffee have been analysed thoroughly in recent years (Flament, 2002). The constituents of coffee beans include minerals, carbohydrates, proteins, caffeine, chlorogenic acids, glycosides, lipids and those transforms or formed at roasting such as trogonelline and the volatile constituents which create the unique flavour. During roasting more than 500 compounds are formed by Strecker and Maillard reactions as predominant reactions (Flament, 2002). Specific precursors, pathways and a better insight into the fundamental chemistry leading to key flavour compounds may be elucidated by new analytical techniques.

Tea

Tea is mainly consumed in the form of 'fermented tea' or 'black tea', yet 'non-fermented' or 'green tea' and lesser known 'semi-fermented' or 'oolong tea' are also available (Deak *et al.*, 2006). Tea was initially used as medicine, later as beverage and now proven well as future potential of becoming an important industrial and pharmaceutical raw material. The beneficial effects have been attributed to the polyphenolic constituents. Several studies suggest that phenolics may be of importance in reducing the incidence of degenerative disease such as cancer and arteriosclerosis. The most beneficial effects of tea are attributed to their antioxidant, cardiovascular, anticancer, antidiabetic, antiarthritic, antiplaque, antiviral, anti-AIDS, anorectic and antimicrobial activities. It has also been reported that green tea polyphenols exhibit neuromuscular, antiangiogenic, antihepatotoxic, antiproliferative/apoptotic and immunomodulatory effects (Sueoka *et al.*, 2001). The most relevant compounds in dietary regime are cinamic acid derivatives and flavonoids.

Coconut

Coconut is a crop of many uses. Primary products of coconut are copra, oil, coir, and tendernut water. Copra, the dried endosperm, is of two types, milling and edible. Milling copra is used to extract oil while edible copra is consumed. Milling copra is manufactured by sun drying or using modern hot air driers. Coconut oil is made from fully dried copra by pressing or solvent extraction. Coconut oil is used as cooking oil, hair oil, body oil and industrial oil. Filtered coconut oil is used for cooking and toiletry purposes. Refined coconut oil is used in the manufacture of biscuits, chocolates and other confectionery items, ice cream, pharmaceutical products and costly paints. Coconut cake, the residue left after the extraction of oil from copra, is mainly used as a cattle feed. Virgin coconut oil is extracted from the fresh endosperm milk. Traditionally, virgin oil is prepared by boiling method. At present, it is produced by adopting wet processing technology.

Fresh endosperm is used to make many products. Desiccated coconut, coconut cream, coconut milk and spray dried coconut milk powder are some of them. They are used in various food preparations. Liquid endosperm or the tender coconut water is a natural nutritious beverage. It has caloric value of 17.4 /100g. It has numerous medicinal properties and is used for treating intestinal disturbances, kidney and urethral stones, dehydration, cholera, urinary infections and malnourishment. Technologies for the preservation and packing of tender coconut water have been developed. Mature coconut water is used for making vinegar and Nata-de-coco, a gelatinous delicacy.

Another important product from coconut is the inflorescence sap popularly known as toddy. Sweet toddy (unfermented toddy) is a healthy drink and also used to prepare jaggery. Toddy on fermentation becomes an alcoholic drink. Arrack and vinegar are also manufactured from coconut toddy.

Coconut fibre is the raw material for industrial units manufacturing coir and coir based products. Coir fibre is extracted from the fibrous outer cover of the fruit of the coconut palm, with or without retting. Coir yarn is generally of 2 ply, spun from coir fibre. Creel mats are manufactured both on handlooms and power looms. Coir mats are made on handlooms, power looms or frames and with or without brush. Coir geotextiles protect land surface and promote quick vegetation. Totally biodegradable, geotextiles help soil stabilisation and renew vegetation in slopes. Coir pith is a spongy material that binds the coconut fibre in the husk. It is a by-product of coir industry. It is an excellent soil conditioner and is being extensively used as a soil-less medium for horticultural purposes.

Coconut shell, leaves and wood are all used in one way or other. Shell charcoal, shell based activated carbon, shell powder, shell handicrafts, shell ice cream cups and bear glasses, ladles, forks, show pieces and shell buttons are the shell based products.

The coconut wood is ideal for making wall panels, furniture, doors and windows. Coconut leaves are plaited and used for thatching houses and sheds. Plaited coconut leaves are also used for making baskets and for erection of temporary fences. Midribs of leaves are used to make brooms.

Arecanut

The economic produce is the fruit called “betel nut” and the dried or processed endosperm is used mainly for masticatory purposes. Many value added masticatory products of arecanut are available in the market. Arecanut has uses in ayurvedic and veterinary medicines. The dried nut has stimulant and astringent properties. It increases the flow of saliva, lessens perspiration and sweetens the breath. It is used in the treatment of intestinal worms (tapeworms & others). It is also used to strengthen gums. The chewing of arecanuts causes mild stimulation and a feeling of well-being.

Though the arecanut is mainly used for chewing purpose, there are many other areas where arecanut is used. Vagbhata (in 4th Century AD) described medicinal properties of arecanut and recommended for treatment of leucoderma, leprosy, cough, fits, worms anemia and obesity. Recent studies have shown that arecanut has pharmacological uses *viz.* Hypoglycemic effect, mitotic activity, antihelminthic activity, cholinomimetic activity etc. Further, arecanut also shows medicinal value as a digestive and carminative, anti-diabetic, against certain skin diseases, as aphrodisiac and relieving asthma. The skin of the fruit is used as an anti-poisonous substance for insect bites.

Tannins are by-product from the process of preparing immature betel nuts for masticatory purposes. Tannic acid from the nut, when mixed with ferrous sulphate in warm distilled water gave black writing ink of acceptable quality. Other uses of tannin are as adhesive in plywood industries and as a textile dye.

The arecanuts contain 8-12 per cent fat. Areca fat has characteristics comparable with hydrogenated coconut oil. Areca fat can be made edible by refining with an alkali. The fat could be softened by fractional crystallization using hexane (25°C) and randomization using sodium methoxide, which gave products desirable for use as confectionery fat.

Arecanut husk is the outer cover of areca fruit. Several processes have been developed for utilization of areca husk for making hard boards and brown wrapping paper. The husk is also used as a substrate for mushroom cultivation. Arecanut husk fibre is longer than jute, goat hair or coir fibre. Arecanut husk has about 50 percent fine fibre and 50 per cent coarse fibre. The tenacity value of arecanut husk fibre was comparable with that of goat hair and jute. The Leaf sheaths of the areca plant are used to make disposable plates and cups. These biodegradable products are finding

ready market in the developed countries. Arecanut husk is used in the preparations of hard boards, paperboards, cushions and non-woven fabrics. Arecanut stem is used as a building material for a variety of construction purposes.

Cocoa

Cocoa pods are the source of commercial cocoa beans. Chocolate is the final product from beans. The intermediate cocoa products are cocoa liquor, cocoa butter, cocoa cake and cocoa powder. Cocoa powder is used as flavor in biscuits, ice cream, dairy drinks and cakes. It is also used in the manufacture of coatings for confectioners or frozen desserts. Cocoa powder is also used in the beverage industry for the preparation of chocolate milk and similar products. Cocoa butter is used in chocolate manufacture and confectionery. In addition, it is also used in the manufacture of tobacco, soap and cosmetics. It is also believed to have antiseptic and diuretic properties. Traditionally it is used in the treatment of burns, cough, dry lips, fever, malaria, rheumatism, snakebite and wounds.

Rubber

The most important use of this highly versatile natural elastomer is in the automobile tyre manufacturing industry, which consumes about 55% of the natural rubber produced in India. The outstanding process ability of this elastomer with its high resilience, low heat build-up and excellent dynamic properties makes it an ideal material for automobile tyres (Mathew, 2001). Apart from automobile tyres, natural rubber also finds application in the production of conveyer belts, hoses, cycle tyres, footwear, engineering products, various latex based products like gloves, dipped goods, rubber backed carpets, adhesives etc. (Annamma Varghese, 2006). Rubber plantations also serve as a good source to generate ancillary income from three major by-products *viz.*, rubber seed, rubber honey and rubber wood.

Biodiversity

The Global Biodiversity Convention signed by representative of over 150 nations at Rio de Janeiro in June, 1992 recognizes that States have sovereign rights over their biological resources. The convention further places the ways and mode for sharing economic benefits accruing from the use of biodiversity among contracting parties on mutually agreed terms (Kannaiyan, 2006). Biodiversity conservation is increasingly being recognized as a fundamental component of sustainable development. In this context, the genetic diversity reported in the plantation crops are furnished below.

Coffee

Conservation and sustainable use of plant genetic resources have long been focal points of national and international agenda. There is growing awareness of conservation

measures by national and international organizations. Coffee trees are classified in two genera, *Coffea* and *Psilanthus*, each genus being divided into two sub-genera (Bridson and Verdcourt, 1988). All *Coffea* species are native to the inter-tropical forest of Africa, Madagascar and Islands of the Indian Ocean. Species belonging to the genus *Psilanthus* originate from either Asia or Africa. *Coffea arabica* is commercially one of the important crops and at the same time, one of the most neglected crops in the world with regard to genetic conservation. The forests housing much of the coffee genepools are being lost at an alarming rate, hence there is urgent need to save the wild coffee genepool (Dulloo *et al.*, 1998). Gole *et al.* (2002) described the geographic and genetic origin of coffee, the diversity of the genepools, human impact on the forest landscape and the current conservation status of the coffee.

Camellia sinensis (L.) O.Kuntze (Tea)

Various authors traced the origin of tea to central China, somewhere in the Mangolian plateau (Weatherstone, 1992). From this primary centre, it spread towards the south to the secondary centre which is near the source of the Irrawady river (Barua, 1989). From this secondary centre, further dispersal took place in three different directions along the sources of the three great rivers, Yang-Tse, Mekong and Brahmaputra (Bezbaruah, 1999). The genus *Camellia* is indigenous throughout the forests of South East Asia where it grows as a tree. Sealy (1958) in his monograph 'A Revision of the Genus *Camellia*' included 82 species (Barua, 1989) in the recent literature available from China, more than 200 species under this genus have been described (Singh, 1999).

The present day commercial tea populations belong to *C. sinensis* (L.) O. *kuntze* (China type), *C. assamica* (Masters) Wight (Assam type) and *C. assamica* ssp. *lasiocalyx* (Planch.ex. Watt) Wight (Cambod type). These three caffeine producing taxa, due to their our breeding character underwent natural hybridization with the non-tea producing taxon *C. irrawadiensis* Barua and other closely related species, and resulted in high heterogeneity in the present day commercial seedling population (Satyanarayana and Sharma, 1993).

The genetic diversity of tea consists of cultivated species, wild genera and species, weedy relatives, old seedling populations, biclinal and polyclonal seed stocks, and clones. While most of the genera of family theaceae and different species of *Camellia* are found in yunnan province in South-West China (Singh, 1999). Besides the tea producing taxa, several other species such as, *C. caudate* Wallich, *C. caduca*, *C. drupifera* Lour. And other related genera, such as *Eurya*, *pyrenaria*, *Schima* and *Gordonia* are also found in the forests of North-East India (Singh, 1999).

Cocos nucifera (Coconut)

Cocos is a monotypic genus. The evidence is in favour of its origin somewhere in

South-East Asia and it is rather speculative to further specify the area of origin. From the centre of origin, it moved eastwards to Pacific and further into America and towards the West to India and Madagascar over the sea (Harries, 1978). Over the years, tremendous variability has been generated in the crop due to cross-pollination. Two distinct varieties are generally recognized. The tall (typica) occupy most of the area. As the name indicates, they are tall palms growing up to 30 m and take 6 to 7 years to fruit. They yield 80-100 nuts per year and the nuts give 150-200 g good quality copra with 65-70 per cent oil. Cultivars like West Coast Tall (WCT), East coast Tall (ECT), Laccadive ordinary (LCT), Andaman ordinary (ADOT), Straight Settlement Apricot (SSAT) etc. fall in this group. Dwarfs (nana), on the other hand, do not grow over 10 m and come to bearing in 4 years after planting. The leaves are smaller. Female flowers that are produced in large numbers are retained. There is a high amount of selfing due to overlapping of male and phases in the female inflorescences and, hence, are more homozygous. Although, they yield over 150 nuts, there is a tendency for alternate bearing. The nuts are smaller containing 90-120 g copra per nut and the oil content is only about 65 per cent. Dwarfs are grown mainly for tender nut and ornamental purposes. Two dwarf cultivars from Chowghat Orange Dwarf (COD) and Chowghat Green Dwarf (CGD). Gangabondam (GBGD) is another dwarf from Andhra Pradesh. Swaminathan and Nambiar (1961) deduced that the dwarfs have originated from tall either through mutation or inbreeding. Intermediate types like Ayiramkachi from Tamil Nadu has also been reported.

Areca catechu (Arecanut)

The genus *Areca* has 76 species. Among these, *A. catechu* L. is the only cultivated species, though nuts of few other species like *A. triandra* Roxb. are also used for masticatory purposes (Nampoothiri *et al.*, 1999). Five botanical varieties of *A. catechu*, namely, *A. communis*, *A. silvatica*, *A. batanensis*, *A. deliciosa* and *A. longicarpa* have been reported based on size and shape of fruits and kernels. Bavappa and Raman (1965) observed mostly bivalents with a rare quadrivalent in *A. catechu* and only bivalents in *A. triandra* and they suggested a secondary allotetraploid origin for *A. catechu*. There are many reports speculating the origin of arecanut palm. The suggested origins are in India, china, Malayan peninsula, East Indies and Indonesia (Sunda Islands). Prevalence of germplasm diversity, supports East Indies group of islands as the centre of origin.

Theobroma cacao L. (Cocoa)

Based on pod and bean characters, three varieties are recognized, namely, Criollo, Forestero and Trinitario. Criollo cocoa pod is big with prominent beak, constriction and furrows. The finished product of whitish or light brown beans has a mild chocolate flavour. The tree is very sensitive to stresses. Though, some plants of Criollo are

found, the bulk of India cocoa belongs to the Forestero. The Forestero produces pod which is small with smoother surface and less prominent beak and Trinitario has evolved through genetic mixing of the other two types, thus, it has acquired characters of both. Within the varieties, a lot of variation exists.

Hevea brasiliensis (Wild ex. Adr.de Juss.) (Rubber)

Hevea occupies the whole of Amazon River basin in Brazil. Currently, a total of 10 species are recognized in the genus. Genetic base of the crop in the East is very narrow, limited to a few seedlings originally collected from a miniscule of genetic range in Brazil referred to as 'Wikham base' (Simmonds, 1989). These were collected from Boim, near the Tapajos river in Brazil. The base has further narrowed down through unidirectional selection for yield, a cyclical generation-wise assortative breeding pattern and a wider adoption of clonal propagation by budding. The parentage of popular clones bred in various rubber growing countries can be traced back to a handful of parental clones (Tan, 1987).

Patents

A patent is a set of exclusive rights granted by a state to a patentee for a fixed period of time in exchange for a disclosure of an invention. The procedure for granting patents, the requirements placed on the patentee and the extent of the exclusive rights vary widely between countries according to national laws and international agreements. Typically, however, a patent application must include one or more claims defining the invention which must be new, inventive, and useful or industrially applicable. The exclusive right granted to a patentee in most countries is the right to prevent or exclude others from making, using, selling, offering to sell or importing the invention.

Representative lists of patents obtained from different countries are given below.

Patent number	Year	Inventor	Patent details
Coconut			
United States Patent 4107383	1978	Reid, Brian C.	Electric cable insulating compositions containing coconut shell flour filler
United States Patent 4296136	1981	Zicarelli, Salvatore F.; Ramos, Rey C.; Brown, Robert M.	Coconut powder
United States Patent 4350088	1982	Rubio, Jr., Jose V.	Coconut shredder and cutter appliance
United States Patent 4383479	1983	Hill, Edward D.	Coconut husk removing tool

Patent number	Year	Inventor	Patent details
United States Patent 4441410	1984	Thompson, Noel A.	Coconut grater
United States Patent 4708056	1987	Dinanath, Chandra	Coconut dehusking machine
United States Patent 4680179	1987	Lidman, Leonida L. M.	Coconut fruit(s) flavored brandy
United States Patent 5164355	1992	Farris, Thomas S.; Coe, Charles G.; Armor, John N.; Schork, Joan M.	High capacity coconut shell char for carbon molecular sieves
United States Patent No 5229290	1993	Ueda, Shinta; Sugimura, Yukio; Otsuji, Kazuya; Higashi, Wakayoshi; Okamoto, Kikuhiko	A method is provided for the regeneration of an individual coconut plantlet.
United States Patent 5594029	1995	Bencsits, Franz;	The invention relates to the use of natural or synthetic first running coconut fatty acid as an insect-repellent agent which is applied to human or animal skin or to clothing.
United States Patent 5698254	1997	Campbell, Iain James; Moriarty, Evelyn Mary; Sibuea, Yenni;	Coconut cream alternative and method of preparing same
United States Patent 6083621	2000	Sugimoto, Ichiro;	Biodegradable plastic product made from coconut husk fiber powder mixture
United States Patent 20040025422	2004	MacQuoid, Malcolm (Park City, UT, US) Keene, Charles (Park City, UT, US)	Pelletized coconut coir and method of use
United States Patent 20050163906	2005	Silva, Guillermo (North Miami, FL, US)	Coconut beverage and method of producing the same
United States Patent 20050013909	2005	Baensch, Werner (Holzminden, DE, US)	Process for defatting coconut meat
Cocoa			
United States Patent 5668007	1997	Spencer, Margaret Elizabeth (Sheffield, GB) Hodge, Rachel (Leicester, GB)	Recombinant 21 kD cocoa protein and precursor
United States Patent 5770433	1998	Spencer, Margaret Elizabeth (Sheffield, GB) Hodge, Rachel (Leicester, GB) Deakin, Edward Alfred (Sheffield, GB) Ashton, Sean (Sheffield, GB)	Recombinant 47 and 31KD cocoa proteins and precursor
United States Patent 6423743	2002	Romanczyk, Jr., Leo J. (Hackettstown, NJ, US)	Cocoa extract compounds and methods for making and using the same

Patent number	Year	Inventor	Patent details
United States Patent 20030219511	2003	Laloi, Maryse (Lausanne, CH) McCarthy, James (Noizay, FR) Bucheli, Peter (Shanghai, CN)	Carboxypeptidase of cocoa
United States Patent 20030157207	2003	Hammerstone, John F. JR. (Nazareth, PA, US) Chimel, Mark J. (Long Valley, NJ, US)	Method for extracting cocoa procyanidins
United States Patent 20040161740	2004	Petiard, Vincent (Tours, FR) Crouzillat, Dominique (Cerelles, FR)	Method of determining the genetic material of cocoa in fermented or roasted beans and chocolate
United States Patent 7122366	2006	Bucheli, Peter (La Ville aux Dames, FR) Laloi, Maryse (Tours, FR) Mc Carthy, James (Noizay, FR)	Cacao endoproteinases and production of cocoa flavor from same
United States Patent 20070134400	2007	Kealey, Kirk S. (Lancaster, PA, US) Snyder, Rodney M. (Elizabethtown, PA, US) Romanczyk, Leo J. JR. (Hackettstown, NJ, US) Gever, Hans M. (Hershev, PA, US) Myers, Mary E. (Lititz, PA, US) Whitacre, Eric J. (Elizabethtown, PA, US) Hammerstone, John F. JR. (Nazareth, PA, US) Schmitz, Harold H. (Branchburg, NJ, US)	Process for extracting cocoa polyphenols from cocoa beans
Coffee			
United States Patent 4531003	1985	Hirsbrunner, Pierre (Corseaux, CH) Pavillard, Blaise (Firbourg, CH)	Purification of caffeine
United States Patent 4505940	1985	Jones, Gary V. (Tarrytown, NY, US) Meinhold, James F. (Boonton, NJ, US) Musto, Joseph A. (Bronx, NY, US)	Non-caffeine solids recovery process
Indian Patent 178160	1997	Sudhir Gopalrao Walde; Arugakeerthy Chakkaravarthi; Rudrayya Gurusiddayya; Dubasi Govardhan Rao (CSIR)	A process for making improved decoction of coffee

Patent number	Year	Inventor	Patent details
United States Patent 6207211	2001	Wasserman, Gerald S. (Hoboken, NJ, US) Rerngsamai, Niphon (Old Bridge, NJ, US) Hayes, Dennis F. (Brewster, NY, US) Mofford, Edmund Frank (Jacksonville, FL, US) Dabdoub, Chantal (White Plains, NY, US)	Roasted coffee and coffee roasting method
United States Patent 6392125	2002	Sano, Hiroshi (Ikoma, JP) Kusano, Tomonobu (Ikoma, JP)	Method for producing the transformants of coffee plants and transgenic coffee plants
United States Patent 20020166145	2002	Marraccini, Pierre (Savonnières, FR) Rogers, John (St. Cyr-Sur-Loire, FR)	Coffee mannanase
United States Patent 20030163837	2003	Aldwinckle, Herbert S. (Geneva, NY, US) Gaitan, Alvaro L. (Manizales, CO, US)	Constitutive and inducible promoters from coffee plants
United States Patent 20040199943	2004	Marraccini, Pierre (Londrina, BR) Edmond Deshayes, Alain Francois Paul (Saint Cyr sur Loire, FR) Rogers, William John (St Jean-de-Gonville, FR)	Coffee plant with reduced alpha-D-galactosidase activity
United States Patent 6727406	2004	Stiles, John I. (Kaneohe, HI, US) Moisyadi, Istefo (Honolulu, HI, US) Neupane, Kabi Raj (Honolulu, HI, US)	Purified proteins, recombinant DNA sequences and processes for controlling the ripening of coffee plants
United States Patent 6903247	2005	Aldwinckle, Herbert S. (Geneva, NY, US) Gaitan, Alvaro L. (Manizales, CO, US)	Constitutive α -Tubulin promoter from coffee plants and uses thereof
Tea			
United States Patent 4135001	1979	Edmonds, Christopher J. (South Nutfield, GB) Gudnason, Geir V. (Atlanta, GA, US)	Process for enhancing the color and flavor of tea
United States Patent 4430849	1984	Wilson, Robert W. (Charlotte, NC, US) Trull, Olin C. (Monroe, NC, US)	Harvester for tea or the like
Indian Patent 159431	1987	Pacherla Ramakrishna;Srikantaiah Nagalakshmi;Ramachandran Seshadri;Magadi Subbaiah Ramaswami;Puliyur Krishnaswami Ramanathan Coimbatore Panchanatham Natarajan (CSIR)	An improved process for the preparation of tea infusion with retention of natural flavours

Patent number	Year	Inventor	Patent details
United States Patent 20020137208	2002	Sandal, Indra (Himachal Pradesh, IN, US) Bhattacharya, Amita (Himachal Pradesh, IN, US) Sharma, Madhu (Himachal Pradesh, IN, US) Ahuja, P.S. (Himachal Pradesh, IN, US)	Method for microproduction of tea plants from leaf explants
United States Patent 6599743	2003	Sandal, Indra (Himachal Pradesh, IN, US) Bhattacharya, Amita (Himachal Pradesh, IN, US) Sharma, Madhu (Himachal Pradesh, IN, US) Ahuja, P. S. (Himachal Pradesh, IN, US)	Method for microproduction of tea plants from leaf explants
United States Patent 6652890	2003	Morre, Dorothy M. (West Lafayette, IN, US) Morre, D. James (West Lafayette, IN, US)	Tea catechins as cancer specific proliferation inhibitors
United States Patent 20040216191	2004	Sandal, Indra (Himachal Pradesh, IN, US) Bhattacharya, Amita (Himachal Pradesh, IN, US) Ahuja, Paramvir Singh (Himachal Pradesh, IN, US)	Transgenic tea through biolistic using leaf explants
United States Patent 7129394	2006	Indra Sandal; Amita Bhattacharya; Paramvir Singh Ahuja (CSIR)	The present invention relates to Production of transgenic tea (<i>Camellia sinensis</i> (L.) O. Kuntze) through biolistic.
United States Patent 7129394	2006	Sandal, Indra (Himachal Pradesh, IN, US) Bhattacharya, Amita (Himachal Pradesh, IN, US) Ahuja, Paramvir Singh (Himachal Pradesh, IN, US)	Transgenic tea through biolistic using leaf explants
United States Patent 20070231445	2007	Gehrig, Manfred (Wolnzach, DE, US) Geyer, Stefan (Wolnzach, DE, US) Schulmeyr, Josef (Wolnzach, DE, US) Forchhammer, Birgit (Neustadt, DE, US) Simon, Karin (Pfaffenhofen, DE, US)	Method for Decaffeinating Tea

Traditional Knowledge

Conservationists have advanced various proposals to protect farmer knowledge and engender the farmer participation necessary for continued crop evolution that generates plant genetic resources for food and agriculture. These proposals include increasing the demand for traditional crops by farmers and consumers, enhancing the

supply of those crops, and negotiating a monetary value for crop resources. While achieving *in situ* conservation is possible without changing farmers' customary management of crops as common pool resources, an alternative approach is to negotiate a contract with providers of the resource that involves direct payment and royalties. This bioprospecting mechanism implies a change in the customary treatment of crop genetic resources as common pool goods and is in line with national ownership mandated by the Convention on Biological Diversity (CBD). Until the end of the last century, crop genetic resources were managed as public domain goods according to a set of practices loosely labeled as "common heritage." The rise of intellectual property for plants, the commercialization of seed, the increasing use of genetic resources in crop breeding, and the declining availability of crop genetic resources have contributed to extensive revisions to the common heritage regime. Changes include specifying national ownership over genetic resources and use of contracts in the movement of resources between countries (law.wustl.edu/Journal).

Coconut

- All parts of coconut tree are useful to the man and has been used by man from time immemorial. The native people have developed many technologies for the utilization of coconut products from time to time. Many of these technologies stood the test of time and are being used even today. This traditional knowledge can be the base for further modification to suit modern times.
- Over the years farmers developed many practices for improving coconut in terms of yield and quality. Farmers set apart some of the palms that are regular bearers, with medium sized nuts for seed nut collection. These mother palms are locally known as *Pakku thengu*. Some of the palms are identified for culinary uses where nuts are of medium size with thin husk, high kernel content, and firm kernel suitable for grating and milk extraction. These palms are called *Arappu thengu*. Farmers also identified *Enna thengu* suitable for copra and oil extraction. In addition, farmers' selection over the years lead to the development of certain local eco-types. These eco-types are known by the location were they were evolved. Some of the examples are *Bedakam* (Kasaragod district), *Annur* (Kannur district), *Kuttiyadi* (Kozhikkode district), *Komadan* (southern Kerala), *Sevvalanir* (Pondyicherry) and *Tiptur Tall* (Karnataka). Farmers observed that natural cross progenies of dwarf palms were high yielding. They grow a few dwarf cultivars along with tall populations to collect naturally crossed nuts from dwarfs. They identified hybrid progenies based on the petiole colour.
- Farmers developed certain criteria for the collection of seed nuts. Nuts from bunch on the northern side of the crown, nuts from middle of bunch, thin husk and high copra are preferred traits. Seed nuts are put in water and those floating up right with

stalk side up are selected. Seed nuts are dried in shade for two weeks and then put in water for three to four weeks.

- Normally one-year-old coconut seedlings are planted in the field. Transplanting three to five month old coconut sprouts, referred as *Mulathai/Kathi kombu/Kakka mookku*, are practiced by farmers. Plaited coconut leaves are used to provide shade to the seedlings by keeping the leaf on the southern side. In water scarcity areas seedlings are irrigated by pitcher irrigation (*Kudam vekkai*) method. Here earthen pots with minute pores filled with water are kept near the seedling. This ensures slow release of water. This is a very effective method wherever water availability is a problem.
- Much traditional knowledge has been evolved in the cultivation practices followed by farmers. Traditionally farmers sow cowpea or other pulses as a green manure in the basins and then incorporate the biomass *in situ*. Application of common salt at base as well on the crown is an age-old practice. Preparation of soil mounts is another practice followed by farmers. This practice helps in conservation of soil moisture, weed control and pruning of surface roots. Another soil moisture conservation method followed is husk burial.
- Farmers developed many plant protection methods to control various diseases and pests. Rot (wilt) disease is a major problem in southern Kerala. Farmers developed certain innovative methods to counter severity of the disease. Application of *Kanjiram (Strychnus sp.)* leaves, fruits of *Marotti (Mahua sp.)*, crushed onion mixed with salt, rind and leaves of tapioca and pouring of gingilly oil to the spindle are practiced by farmers. Stem bleeding disease is managed by indigenous methods like, application of neem cake, cashew nut shell oil and lime paste. Farmers manage bud rot disease by traditional methods like burning *neettu kakka* (Calcium carbonate) and applying it along with ash to the basins, removing affected part and application of salt and ash mixture at crown and application of bleach on the crown.
- Rhinoceros beetle, red weevil and eriophyid mite are the major pests of coconut. Rhinoceros beetle feed on the tender leaves of the coconut. Farmers developed various methods to control rhinoceros. Hooking out the beetle is the traditional mechanical method followed. Filling leaf axil with a mixture of salt, sand and ash is another practice followed by farmers. Cow dung pits are breeding grounds for the weevil. Farmers add leaves of *Perumaram (Ailanthus sp.)* or *Karinochi (Vitex sp.)* in the cow dung pits to control the breeding of this pest. Caster cake solution and jaggery solution are used to attract and trap the weevil.
- Red weevil of the coconut kills the palm if not treated at right time. Farmers make traps of coconut frond smeared with toddy to attract and kill the weevil. Another type trap is a wide mouthed pot in which a mixture of castor oil cake and rice gruel

is placed. A mixture of pineapple pulp yeast and toddy is also used to attract and trap the weevil.

- Eriophyid mite is a sap sucking microscopic insect living on a developing nut in between calyx and husk. Farmers developed many herbal preparations to control the pest. One of such preparation is a mixture of custard apple, turmeric, clerodendron, aloe, neem, nochi and calotropis. Another practice is to mix jaggery with insecticide as sticking or wetting agent.
- Farmers use traditional methods to control rat in coconut garden. Farmers wrap trunk with polythene sheet or tin sheet up to five to eight feet. Bait is prepared in the shape of a small ball by mixing cotton with jaggery. This, once eaten, results in the death of rats.
- There are other practices in coconut cultivation where farmers developed indigenous technologies. Farmers apply lime to prevent the development of barren nuts. Coconut parts like husk, shell, leaves and fronds are burnt at the basin. Farmers believe this practice increases yield. Coconut husks are used as steps by tying on to the trunk to aid in climbing.
- Farmers follow various climbing methods. Using a *Talappu*, made of coir or cloth to get grip for hands and feet, skilled climbers reach the crown with ease. Another climbing method is by using bamboo ladder slanting on trunk. A bamboo pole with knife attached is also used for harvesting coconut.
- Husking of coconut fruit require special devices. Farmers over the years developed some. *Vettukathy* is a knife with broad blade used to husk the coconut. *Paara* or crowbar is metal pole with sharp and tapering edge on to which coconut is hammered to split open the husk.
- Extraction of oil from dried endosperm or copra, as it is popularly and commercially known, is by an indigenously developed device called *chekku* or *ghana*. It is a bullock driven pestle and mortar system. Mortar is made of wooden or stone and the pestle is wooden.

Arecanut

- Arecanut has played a very important role in the upliftment of rural India by giving handsome returns to the farmers cultivating it. For the same reason, farmers tended the arecanut plantation with great care and devotion. This has resulted in the development of much traditional knowledge associated with the arecanut cultivation.
- Farmers follow various indigenous practices for production of quality planting material. Mother palm selection is very important in the production planting material. Farmers select regular bearing and high yielding palms that produce four or more bunches per annum with 250 or more nuts per bunch. Farmers

also practice nut selection. Middle bunches (*Naduppolikkal*) are selected for nut collection. Collected seed nuts are put in water and those nuts that float vertically with calyx end pointing upwards are selected. Farmers treat the seed nuts for better germination. The seed nuts are smeared with cowdung slurry and are kept under shade for 2-3 days. Farmers select seedlings based on the number of leaves and shape of spindle leaf. Seedlings with 5-6 leaves and sword shaped spindle leaf are selected.

- Seedlings planted in the field are managed very well. *Oliya* (channel) is dug between every two rows of arecanut wherever water stagnation is a problem ensures proper drainage. Farmers cultivate banana as an intercrop in young gardens to provide shade. Arecanut leaves are used to cover the southern side of seedlings and palms to protect from sun in summer months. Some farmers apply lime on southern side of the palms to protect it. Splash irrigation is an indigenous method developed to irrigate arecanut gardens. Here channels (*Oliya*) are prepared between rows of arecanut and water is splashed to the basin of arecanut.
- Traditionally a small curved knife fitted on wooden platform is used to husk the dried arecanut fruit. A worker can sit on the platform and husk about 60-70kg dried nuts.

Trade Mark

A trademark or trade mark is a distinctive sign or indicator of some kind which is used by an individual, business organization or other legal entity to uniquely identify the source of its products and/or services to consumers, and to distinguish its products or services from those of other entities. A trademark is a type of intellectual property, and typically comprises a name, word, phrase, logo, symbol, design, image, or a combination of these elements. There is also a range of non-conventional trademarks comprising marks which do not fall into these standard categories.

In order to protect 'Darjeeling' and 'Darjeeling logo' as GI, the Tea Board of India registered the marks in various countries, including the United States, Canada, Japan, Egypt, and the United Kingdom and some other European countries, as a trade mark/CTM. In this context it is relevant to note that on 3 August 2001 the UK Trade Registry granted registration of the word 'Darjeeling' as of 30 March 1998 under the UK Trade Marks Act 1994. The United States has also accepted the application of the Tea Board for the registration of 'Darjeeling' as a CTM in October 2002.

In Ethiopia there are a number of terms customarily used by the coffee trade based on the various districts where the coffee is grown, such as Harrar (or Harar), Sidamo, Limu, Yirgacheffe (or Yrga Cheffe), Kaffa, Gimbi (or Lekempti), and Djimmah.

For the past 100 years both coffee exporters and roasters have used these words on their bags and packages to connote the districts in Ethiopia where the coffees originated, as many of these coffees show distinct differences in their flavor profiles. Harrar, Sidamo, Yirgacheffe and Limu have become more widely known to consumers in the last 20 years, largely due to the growth of the speciality coffee industry. In 2005, the Ethiopian government initiated a program to “register trademarks for Harrar, Yirgacheffe, and Sidamo in 40 countries—and eventually four other well-known Ethiopian fine coffees with good reputations” (<http://www.coffeegeek.com/resources>).

Geographical Indications

The use of geographical indications allows producers to obtain market recognition and often a premium price. With the increased internationalization of food and product markets, geographical indications have become a key source of niche marketing. Geographical indications are also often associated with non-monetary benefits such as the protection of knowledge and community rights (<http://www.geographicindications.com>).

Darjeeling tea

Given that Darjeeling tea has a high reputation, both the Tea Board and the Darjeeling Planters Association have been involved at various levels in protecting this common heritage. The Tea Board has obtained “home protection” by registering the Darjeeling logo and also the word “Darjeeling” as a Certification Mark under the Indian Trade and Merchandise Marks Act, 1958. Under the new Geographical Indication of Goods (Registration & Protection) Act, 1999, (which has become operational on September 15, 2003), the Tea Board has also filed applications for the Darjeeling logo as well as “Darjeeling” word to be registered as a geographical indication.

Overseas, the Darjeeling logo and word are registered or applied for registration under the relevant laws available in the country where registration is sought. The present position of international registration of Darjeeling and Darjeeling logo is given hereunder.

Country	Nature and subject matter of registration	Registration no.	Validity
Canada	Certification Mark	0903697	Valid until voluntarily abandoned or expunged pursuant to a court order.
Egypt	Trade Mark	103072	April, 2009
International Registration—Germany, Austria, Spain, France, Portugal, Italy, Switzerland and former Yugoslavia.	Collective Mark	528696	September, 2007.

Country	Nature and subject matter of registration	Registration no.	Validity
Benelux registration– Belgium, Netherlands, Luxembourg	Collective Mark	444511	March 2007
India	Certification Mark for DARJEELING logo	532240	October 9, 2007
India	Certification Mark for DARJEELING (word)	831599	December 10, 2005
Japan	Trade Mark for the DARJEELING logo	2153713	July, 2007
U.K.	Certification Mark for the Darjeeling logo	1307518	April, 2008
U.K.	Certification Mark for Darjeeling (word).	2162741	March 30, 2008
U.S.A.	Certification Mark Darjeeling logo	1632726	January, 2007
U.S.A.	Certification Mark for Darjeeling word per se.	2685923	October 1, 2012
Russia	Darjeeling logo Darjeeling word		Pending application dated April 1999. Word recently accepted for registration.

(Rajendra Kumar and Vasundhara Naik, 2007)

Monsooned Malabar Coffee

Coffee Board, India is working on to get GI for Monsooned Malabar Coffee, the specialty coffee of India. Indian coffee is well known for its defined characteristics like good body, mild acidity, pleasant aroma and flavour in the cup. In addition to regular coffees, Monsooned coffee is unique to India alone. These epicurean coffees are fortune coffees to have processed only in India and were launched into international market as early as 1972. Monsooned coffee are unique speciality coffee in the world specialities. It is exclusively prepared and exported only from India to cater to the demands of other countries in the world market. This special traditional process of monsooning is carried on the west coast of Malabar regions renowned for excellent natural resources specifically for the humid monsoon atmosphere to bring qualities and quantitative changes in the coffee beans that offers a unique cup.

Conclusion

The IPRs relevant to plantation crops are patents, particularly on biotechnological inventions and plant variety protection. Trademarks and geographical indications are

considered to be part of IPRs and these are relevant to the plantation sector also. Traditional knowledge has always had spiritual and utilitarian value to indigenous peoples, but in the last few decades its value for commercial uses has also been recognized. The intellectual property rights designed to protect commercial innovations has to recognize and protect the traditional knowledge.

References

- Annamma Varghese, Y., Saji T. Abraham, Jayashree Madhavan. (2006). Rubber. In Plantation crops Vol I. (Eds V.A. Parthasarathy., P.K. Chattopadhyay and T.K. Bose). pp. 345-482. Naya Udyog, Kolkatta.
- Anonymous (2007). *Tea statistics*. Available on line at <http://www.teaboardofindia.in> (Accessed on 1 December 2007).
- Arulraj S., Thamban C., Anithakumari, P and Kalavathi S. (2002). Indigenous knowledge in coconut and arecanut cultivation, p 50. CPCRI, Kasargod.
- Barua, D. N. (1989). *Science and practice in tea culture*. Tea research Association, Calcutta, India.
- Bridson, D.M. and Verdcourt, B. (1988). *Rubiaceae, Part 2*. In Flora Zambesiaca, 5(2). Kew: Royal Botanic Gardens, Kew. 211-377.
- Bavappa K.V.A and Raman V.S. (1965). Cytological studies in *Areca catechu* L. and *A. triandra* Roxb. *J. Indian Bot. Soc.*, 44: 495-505.
- Deka, A., Deka, P.C. and Mandal, T.K. (2006). Tea. In Plantation crops Vol I. (Eds V.A. Parthasarathy., P.K. Chattopadhyay and T.K. Bose). pp. 1-147. Naya Udyog, Kolkatta.
- Dulloo, M.E., Guarino, L., Engelmann, F., Maxted, N., Newbury, H.J., Attere, F. and Ford-Lloyd, B.V. (1998). Complementary conservation strategies for the genus *Coffea*: A case study of Mascarene *Coffea* species. *Genet. Resources and Crop Evolution*, 45: 565-579.
- Flament, I. (2002). *Coffee Flavour chemistry*. John Wiley & Sons Ltd., Chichester, England.
- Gole, T.W., Denich, M., Teketay, D. and Vlek, P.L.G. (2002). Human impacts on *Coffea arabica* genetic pool in Ethiopia and the need for its in situ conservation. In Managing plant genetic diversity (Eds J. Engels, V. Ramanatha Rao, A. H. D. Brown and M. Jackson). pp. 237-247. IPGRI, Rome.
- Harries (1978). The evolution, dissemination and classification of *Cocos nucifera* L. *Bot. Rev.*, 44:265-319.
- Kannaiyan, S. (2006). Biodiversity and bioresources conservation. In Biodiversity in India: Issues and Concerns (Eds S. Kannaiyan and A. Gopalam). pp. 1-12. Associated Publishing Company, New Delhi, India.
- Mathew, N.M. (2001). Natural Rubber. In Rubber technologist's handbook (Eds. J.R. White and S.K. De) pp. 1-41. Rapra technology Ltd, UK.
- Rajendra Kumar and Vasundhara Naik. (2007). *Darjeeling Tea – Challenges in the Protection and Enforcement of Intellectual Property Rights*. Available online at http://www.wipo.int/sme/en/case_studies/darjeeling_tea.htm (accessed on 21 August 2007).
- Ratnambal, M.J., Nair, M.K., Muralidharan, K., Kumaran, P.M., Bhaskara Rao, E.V.V and Pillai, R.V. (1995). *Coconut Descriptors part I*. Central Plantation Crops Research Institute, Kasaragod, Kerala.
- Rethinam, P. (2003). Prospects for the Coconut industry. *Journal of Plantation Crops*, 31 (1): 1-7.
- Sealy, J.R. (1958). A revision of genus *Camellia*. The Royal Horticultural Society, London, UK.

- Simmonds N. W. (1989). Rubber breeding. In Rubber (Eds. C.C. Webster and W.J. Baukwill) pp. 97-99. John Wiley and Sons, New York, USA.
- Singh, I.D. (1999). Plant improvement In Global advances in tea science (Ed N. K. Jain). pp. 97-99. Aravalli Books International Pvt. Ltd., New Delhi, India.
- Schilter, B., Cavin, C., Tritscher, A and Constable, A. (2001). Coffee: health and safety considerations. In: Coffee, recent developments, (Clarke, R.J and Vitzthum, O.G. eds), Blackwell Science, Oxford, London, pp. 165-183.
- Sueoka, N., Suganuma, M., Sueoka, E., Okabe, S., Matsuyama, S., Imai, K., Nakachi, K and Fujiki, H. (2001). A New Function of Green Tea: Prevention of Lifestyle-related Diseases. *Ann. N.Y. Acad. Sci.*, 928: 274-280.
- Swaminathan M.S and Nambiar, M.C. (1961). Cytology and origin of the dwarf coconut palm. *Nature*, 192: 85-86.
- Tan, H. (1987). Strategies in rubber tree breeding. In Improving vegetatively propagated crops (Eds. A.U. Campbel, A.J. Abbot and R.K. Atkin). pp. 27-62. Academic Press, London, UK.
- Weatherstone J. (1992). Historical introduction. In Tea: Cultivation to consumption. (Eds. K.C. Willson and M.N. Clifford). Chapman and Hall, London, UK.