

High value fruit trees in coconut based mixed cropping system

P.K. Thampan

Introduction

Tropical Asia is endowed with favourable climatic features for the cultivation of a large variety of fruits. Among the fruits commonly grown, there are some which are downright delicious and pleasing. They are not available in any other part of the world and are, hence, a source of attraction to tourists from far and wide. While these special fruits are found in all the Asian Countries, they are presently available in sizeable quantities only in Malaysia, Thailand and Indonesia. In India the climatic features permit their cultivation on the West Coast, but they are yet to become popular among the farmers and consumers alike. Organized efforts in this direction are needed to popularize the cultivation of the most delicious fruits for direct consumption as well as for processing.

Compatible Fruit Trees under Coconut

Selected high value fruit trees could be integrated in the coconut holdings as components of a mixed cropping system. Such trees, depending on their stature and growth behavior, are to be grown either as regular intercrops or stray plantings. Special quality fruit trees that are amenable to be included in the cropping system are highlighted in this paper.

1. Avocado (*Persea americana* Mill.)

Avocado is a medium sized, erect and dense tree, growing to a height of 6-8 m. Among the coconut growing States in India its cultivation is confined mostly to coastal Karnataka. Although the plant is adaptable to diverse soil conditions, the preference is for well drained sandy loam with pH between 6.0 and 7.0. Propagation is through seeds or grafts. The seedlings commence fruiting 7-8 years after planting whereas the grafts begin fruit bearing after four years. The usual productivity at full bearing stage is about 500 fruits per tree per annum. The fruit may be round, pear shaped or oblong, 7.5 to 30 cm long and upto 15 cm wide.

Avocado fruit has one large seed in the centre making upto 10-25 percent of the fruit weight. It is surrounded by a thick fleshy layer which is greenish yellow to bright yellow when ripe and buttery in consistency. This layer is the edible portion which is rich in monounsaturated fats and many essential nutrients. The edible part per 100 g contains 26.4 g fat, 1.7 g protein, 5.1 g total carbohydrates, 1.8 g crude fibre, 10 mg calcium, 11 mg chlorine, 0.45 mg copper, 0.6 mg iron, 35 mg magnesium, 4.21 mg manganese, 38 mg phosphorus, 548 mg potassium, 10.5 mg sodium and

The fruit trees listed in this paper are amenable to be introduced as companion crops in coconut-based cropping system. Special promotional efforts are needed in this direction in those coconut growing states where congenial agro-climatic features prevail. The availability of these fruit trees in coconut holdings will contribute to household food and nutrition security as well as on-farm income.

28.5 mg sulphur. The contents of vitamins are 0.17 mg carotene, 16 mg ascorbic acid, 1.1 mg niacin, 0.13 mg riboflavin and 0.06 mg thiamin. The edible portion has an energy value of 245 calories. Regular intake of avocado has beneficial effects on serum cholesterol levels. Diet rich in avocado has been found to decrease the levels of both LDL-cholesterol and triglycerides. High contents of antioxidants in the fruit guard against lung and breast cancer, heart diseases and ageing. The presence of potassium helps regulate blood pressure.

2. The Durian (*Durio zibethinus* Linn.)

The durian tree is large evergreen which may grow to 25-30 m or more in height. It comes up well in humid low land areas below 800 m elevation. In Malaysia the tree starts bearing in 7-8 years while under Indian conditions the pre-bearing period may be more. The propagation is usually through seeds soon after extraction from the pulp. In pure plantations the seedlings are planted at a spacing of 10-12 m. Propagation by inarching and budding is also feasible. The tree has characteristic oblong leaves which are densely covered with golden hairs on the undersurface. The flowers are large and whitish. After flowering each fruit takes three months to develop and it is not considered fully ripe until it drops from the tree. The average yield of a fully grown tree is 40-50 fruits in a year. In the major centres of production unripe fruits are sometimes consumed as a vegetable. Different varieties of durian are available for cultivation. In Thailand

four varieties are popular. They differ in the shape, weight and colour of fruits. The pulp also shows slight variation in taste.

The durian fruit arouses strong feelings of love and admiration in many, but dislike and hatred in some. The problem is the smell. The edible portion, though very tasty, emits a strong odour, suggestive of a mixture of old cheese, rotten onion and turpentine. But to those who have acquired the taste, the fruit is exhilarating and the taste becomes a permanent affliction. The very thought of tasting the fruit makes them salivate.

The durian fruit is 15-20 cm in diameter and covered with very sharp, hard spiny projections like jack fruit. Ripe fruits are golden yellow or greenish brown in colour, dark in places. Each fruit weighs 2 to 5 kg. On opening the fruit five oval compartments, each containing a creamy yellow pulp, are exposed. The edible pulp is esteemed for its sweetness and is around 33 percent of the weight of the fruit. Within the pulp, in each compartment, are found one to five chestnut size seeds which can be roasted and eaten. As the ripe fruit deteriorates rapidly, it is not amenable for long distance transport and, hence, becomes available only near the source. At room temperature (25-30 degrees Celsius) the fruits can be kept for 2 to 5 days. Durian ice cream is a delicacy in the larger cities of many Asian countries. Durian admixed coconut candies are produced and marketed on commercial scale in Vietnam. The product is presently available in the international airports and departmental stores in the major

cities. Although isolated trees are found in some gardens in Kerala the fruits are often discarded.

The fruit is high in Vitamin A, Calcium and phosphorus. The edible pulp per 100 g contains 70.9 percent moisture, 3.3 g protein, 4.3 g fat, 19.3 g carbohydrate, 1.2 g fibre, 49 mg calcium, 27 mg phosphorus, and 2.0 mg Fe. The contents of vitamins are 890 I.U. of vitamin A, 1.08 mg vitamin B1, 0.11 mg vitamin B2, 1.0 mg niacin, and 62 mg vitamin C. The pulp has an energy value of 129 calories.

3. Macadamia (*Macadamia integrifolia* M&B)

Macadamia is an evergreen tree growing to a height of about 15 m. The two commonly important species valued for the production of edible nuts are *M.integrifolia* and *M.tetraphylla*. Macadamia nuts are the highly favoured of all edible nuts in the world and are, perhaps, the costliest among them. The nuts in different forms such as roasted salted, chocolate coated etc. are available in most of the international air ports.

Macadamia is considered to be a native of Australia from where the cultivation has spread to other countries. Commercial crops are now being produced in Hawaii, South Africa, Malawi, Kenya, Brazil, Fiji, California etc. In India it is not grown even in States favoured with ideal agro-climatic conditions. In Vandiperiar, Kerala State, a few trees are reported to be growing and producing nuts. Studies have revealed that coconut growing States such as Kerala, Karnataka, Tamil Nadu and Orissa offer

opportunities for the cultivation of macadamia in home gardens as well as in larger holdings under coconut as companion crop.

Among the commercially important species, *M. integrifolia* and its cultivars are adaptive to diverse agro-climatic conditions. On the other hand, *M. tetraphylla* and its cultivars are more adaptive to cooler climate. In general, macadamia prefers well drained deeper soil with pH of 5.5 to 6.0, temperature range of 13-31 degree Celsius, and evenly spread annual rainfall of not less than 125 cm. The limit of altitude for good bearing is upto 600 m above sea level. The tree is propagated both sexually and vegetatively. Seedlings as such or after grafting with the desired cultivar and also cuttings are used as the planting material. Grafting of seedlings is usually done when they are 10-12 months old. After another one year in the nursery the grafted plants are transplanted. Usually several cultivars are grown mixed in order to ensure better pollination. In commercial plantations grafted plants are preferred for planting as they are found to be superior to seedling plants in uniformity in production, productivity and in the out-turn of kernel per nut.

The grafted plants and rooted cuttings start fruiting in 6-7 years after planting. Some may even come to bearing in three years. The seedlings may, however, take 8-12 years to start fruiting. Flowering spreads over several months and the nuts require about seven months for maturity. The tree continues to produce nuts for over 50 years. A fully matured nut is

spherical in shape with a 2-7 mm thick fibrous green pericarp or husk. Inside the husk is a 2-3 mm thick hard brown testa or shell enclosing a nearly spherical white kernel. Although the average annual yield is 50 kg of nuts per tree, it is not uncommon to find plantations where the average yield per tree exceeds 80 kg. The harvesting is protracted over a long period. Round the year harvesting is also common. Harvesting is restricted to the collection of fallen nuts from the ground periodically. Shake harvesting is also adopted in some places. But in this practice immature nuts are also likely to fall and for that reason, it is not commonly adopted as a harvesting method.

Post harvest processing involves dehusking the nuts, drying the dehusked nuts and separation of the kernel. Dehusking of freshly collected nuts and subsequent drying have to commence within 24 hours as otherwise the quality will deteriorate. Dehusking is usually done in mechanical dehuskers. The husk constitutes 40-45 percent of a freshly fallen mature nut. The dehusked nuts are then dried to 1.5 percent moisture from the original level of about 50 percent. At this stage the nuts are cracked to separate the kernel from the shell. In most cases drying and deshelling are done mechanically. The kernels are then processed into different forms and marketed. The common form is roasted salted nuts. The international demand for macadamia nuts has expanded considerably over the years whereas the production has not kept pace.

Macadamia nut is not nutritionally superior to cashew nut. It is, however, preferred over the latter for its finer taste. May be because of this quality and the lesser availability, macadamia nuts are costlier than cashew kernels. The nutritional composition of roasted macadamia nuts per 100 g is: 1.19 percent moisture, 727 calories, 9.23 g protein, 78.21 g fat, 1.40 g mineral matter, 1.84 g fibre, 9.97 g carbohydrates, 53.4 mg calcium, 240 mg phosphorus, 1.99 mg iron, 0.216 mg thiamine, 0.119 mg riboflavin and 1.60 mg nicotinic acid. On the other hand, cashew kernel is richer in protein (21.20 g), mineral matter (2.40 g), carbohydrates (22.30 g), phosphorus (450 mg), vitamin A (100 I.U.), thiamine (0.63 mg), riboflavin (0.19 mg), and nicotinic acid (2.10 mg). Cashew kernel also has lower fat content (46.90 g) and calories (596).

4. Mangosteen (*Garcinia mangostana* Linn.)

Mangosteen is a medium sized tree growing to a height of about 10 m. It comes up well in a warm, humid climate with a rainfall evenly spread. When there is much seasonal variation in rainfall, supplementary irrigation is essential. The preferred altitude range is 300 to 900 m above sea level. The tree fails to survive in areas where temperature falls below 4 degree Celsius and also in places where heavy and constant sea breeze is experienced. The tree is a slow growing evergreen with dark green leaves. The tree has ornamental value and adds beauty to the garden.

Propagation of the tree is through seeds. The seeds are not the product of fertilization and, as such, they

reproduce the characteristics only of the mother tree. Consequently, there will be no genetic variation among the progenies which is a major constraint in the production of superior varieties. The seeds are viable only for a few days after removal from the fruit. They, however, remain viable for three to five weeks if not removed from the fruit. The seeds are sown on germination beds and after sprouting, the sprouts are transferred to polybags. Germination commences about 45 days after sowing. When the seedlings are about 25 cm in height, they are transplanted in the field at a spacing of 9 to 10 m. Fruiting commences only after a long pre-bearing period of 10-15 years. When grown in deep, fertile, well drained and slightly acid soil, the tree yields heavily. Under such conditions the yield may be as high as 1,000 fruits per tree per annum. The normal yield is about 400 fruits per tree. The fruit is the size and shape of a tennis ball with a hard smooth purplish rind, six mm thick. The remnants of the calyx are attached to the top of the fruit.

The fruit of mangosteen is one of the best flavoured tropical fruits in the world. Protected by the hard rind the fruit has five segments, each containing juicy white jelly like edible pulp which is sweet, sub acid, delicately flavoured and refreshing. There are few small seeds, usually five to eight, found embedded in the pulp. The pulp is highly nutritious with high calcium, phosphorus and vitamins B and C. Fresh fruits do not keep long. At room temperature (25-30 degree Celsius) they could be kept for five to seven days. The fruit per 100 g of edible pulp contains 79.2

percent moisture, 0.5 g protein, 19.8 g carbohydrate, 0.3 g fibre, 11 mg calcium, 17 mg phosphorus, 0.9 mg Fe, 14 I.U. of vitamin A, 0.09 mg B1, 0.06 mg B2, 0.1 mg niacin, and 66 mg of vitamin C. The edible pulp does not contain fat. It is neither fattening nor sensitive to stomach. The energy value of the fruit is 81 calories.

As no dependable method has been developed for propagating the plant vegetatively, it is not grown on a large scale. Another constraint is the long pre-bearing period which is not appreciated by the farmers. There are not many varieties in the major growing centres. Perhaps, the fruits that are available in the local markets are from the wild species of the genus *Garcinia*. In Kerala mangosteen is found growing in the gardens of some enterprising farmers. Though the number of trees is not much, the fruiting tendency and the quality of the fruits produced indicate that mangosteen could be cultivated successfully as intercrop in coconut holdings as well as in orchards in selected locations in the State.

5. Pumelo (*Citrus grandis* Linn.)

Pumelo is the largest of all citrus fruits. The tree is medium sized and grows to a height of 5-15 m when fully mature. The young branches are covered with spines. The leaves are broad and shiny. Propagation is usually by seeds. Vegetative propagation is also successful. The progenies raised from seeds show considerable genetic variation. The seedlings after field planting take seven to eight years to commence fruiting. The tree is amenable to cultivation both under rainfed and

irrigated conditions. Under the former condition fruiting is delayed upto eight or nine years. It also comes up well under saline conditions. This characteristic makes the cultivation possible along the seacoast, around river deltas and brackish marshy areas.

After fruiting is commenced, the tree produces good crop regularly. High yielding trees, on an average, produces more than 500 fruits per tree per year. The fruits vary in shape depending upon the variety. In general, the fruit is either globular or pear shaped and the size may range upto 20 cm in diameter. The fruit has a thick rind (upto 2 cm) below which is the edible flesh which is tough and solid. The flesh is usually pinkish in colour and is contained in sections which are separated by thick membranes. The flesh is made up of a number of vesicles or firm fruit sacs. A large number of seeds are embedded in the flesh. Thin skinned pumelo is regarded as the best quality variety. Seedless or nearly seedless varieties are also available. One advantage with pumelo is that the fruits of commercial varieties have a shelf life of three to four months which facilitates long distance transport.

The fruit is nutritive and refrigerant. It is high in vitamins A and C. The flesh is eaten raw and is also made into jams and marmalades. The edible portion per 100 g contains 89.2 percent moisture, 0.5 g protein, 0.4 g fat, 9.3 g carbohydrate, 0.2 g fibre, 9 mg calcium, 21 mg phosphorus, 49 I.U. of vitamin A, 0.07 mg B1, 0.02 mg B2, 0.4 mg niacin, and 44 mg vitamin C. The energy value is 89.2

calories. The leaves of pumelo are considered useful in epilepsy and convulsive cough.

6. Rambutan (*Nephelium lappaceum* Linn.)

Rambutan fruit is very delicious which is, perhaps, the best among the tropical fruits. The tree is medium sized and attractive. It grows to a height of about 12-20 m. Propagation is by grafting or budding, though by seeds is also not uncommon. Seedling plants take 5-6 years to come to fruiting. On the other hand, vegetatively propagated ones reach fruiting in three years. Some budded plants start fruiting within two years. The tree is adapted to warm tropical climate and fails to come up well in temperatures below 10 degree Celsius. It prefers well drained, rich soils with a pH range of 5.5 to 6.5. All trees do not produce fruits as they comprise either male or female or hermaphrodites. There are many favourable tracts on the west coast especially Kerala where rambutan could be successfully grown as a companion crop in coconut holdings.

An average tree produces 5,000 to 6,000 fruits. The fruit is round to oval dupe, 3-6 cm long and 3-4 cm broad. It closely resembles litchi, a fruit grown in some parts of the country especially in Bihar. Each fruit is of the size of a plum, pink or bright red in colour and covered with very soft but thick hairs. In some varieties particularly those yielding bright red fruits, the end of hairs is green. The skin along with the hairs easily peels off exposing the white fleshy meat, which is very sweet. In some varieties, the taste is a combination of sweet and sour. Inside the flesh is embedded a single seed. The flesh is eaten fresh and also after canning. At room temperature (25-30 degree Celsius) the fruits can be kept for three to four days. The seed oil contains oleic and arachidic acids and is used in industrial applications and also for cooking.

Nutritionally rambutan is high in vitamin C, calcium and phosphorus. The sweet flesh per 100 g contains 82.9 percent moisture, 0.9 g protein, 0.1 g fat, 14.5 g carbohydrates, 1.1 g fibre, 3 mg calcium, 6 mg

phosphorus, 1.8 mg iron, 4 I.U. of vitamin A, 0.04 mg B1, 0.05 mg B2, 0.6 mg niacin and 31mg of vitamin C. The energy value is 63 calories.

Conclusion

The fruit trees listed in this paper are amenable to be introduced as companion crops in coconut-based cropping system. Special promotional efforts are needed in this direction in those coconut growing states where congenial agro-climatic features prevail. The availability of these fruit trees in coconut holdings will contribute to household food and nutrition security as well as on-farm income. The national and state level organizations engaged in coconut R&D have to assign importance to the development of special quality fruit trees as compatible combinations of coconut-based cropping system.

Note: This article was prepared after seeing the crops grown by farmers in some parts of Indonesia, Philippines and Thailand and after perusing the write-ups appeared in some publications in the nineties.