COCONUT

Coconut is probably the only tropical crop commercially cultivated extensively in about 86 countries especially on the small and marginal holdings over an area of 9.84 million hectares and produces about 51.3 billion nuts per year. Coconut, considered to be the most important and useful of the tropical palms, has been in cultivation in India from time immemorial. It perhaps yields more products of use to mankind than any other tree. In India as much as 48 per cent of the coconut production is used for edible and religious purposes, 10 per cent as tender coconut, about 30 per cent as milling copra for oil extraction, 8 per cent for the manufacture of edible copra and the balance is processed into products like desiccated coconut and coconut cream.

Coconut bunch support:

Partial severing of the stalk from the trunk is known as buckling. A large number of nuts in the bunch and/or big sized nuts, long and less sturdy peduncle, wider angle between the leaf and the inflorescence and weak leaf petiole are some of the causes for buckling of bunches. To prevent the coconut bunches from buckling, a mechanical support has been developed (CPCRI, 1979) which consists of a trunk-clamp, support-clamps and telescopic support-rods. The trunk-clamp is made in six different sizes to suit varying trunk girths. Support clamps can be placed at any point on the trunk-clamp. Telescopic support-rods are made in two different sizes to suit bunches located at various heights and positions on the crown. The support can easily be fixed on the trunk of the palm either by standing on the ground (if the palm is short) or with the help of a ladder (if the palm has grown tall).

Modified coconut tree climber:

This has many advantages over the traditional tree climbing. It is safe and causes less drudgery for the tree climber. It is convenient to use as the weight is only 9 kg. About 10 – 12 trees can be climbed for harvesting nuts in one hour (UAS, 1997).

Coconut husking machine:

To reduce the cost of transport, coconut is usually husked in the coconut garden itself. Traditionally it is done by impaling the coconuts on a sharp iron spike fixed in the ground at a slight angle from the vertical. Coconut husking is a hard job requiring considerable skill and involves the risk of physical injury.

Coconut Husking Tool (Keramithra):

An easy-to-operate simple coconut husking tool which is particularly useful for domestic purpose has been developed (Jippu Jacob, 1999). It consists of mainly a stationary wedge, a movable wedge, a lever, and a pedestal having a base. In use, the base of the tool is held firmly to the ground using the feet particularly with one foot on the side of the handle. The coconut is thrust on to the husking tool as in the case of crowbar. On pulling the handle upward with one of the hands, one sector of the husk is loosened from the shell. The operations are repeated three or four times for loosening the remaining sectors. It takes only about 8-20 seconds for husking a nut depending up on the variety, maturity etc., of the nut. It is light in weight, simple to use and handle, and can be used both indoors and outdoors. Besides it is cheaper. Its technology has been transferred to the Regional Agro Industrial Development Cooperative of Kerala Limited (RAIDCO), Kannur for mass production and popularization among the public.

Pedal operated coconut dehusker:

This is a modified design based on the one developed by the Kerala Agricultural University (UAS, 2000). This has some advantages over the KAU model. With this unit, less energy is spent for dehusking a coconut and easy to dehusk continuously without much fatigue to the operator. About 100-120 nuts can be dehusked per hour. The unit has been designed to with stand longer use.

Manually operated coconut husking machine:

The manually operated coconut-husking machine (CPCRI, 1986) consists of a platform at waist level, with a frame, a shaft which moves up and down on the platform, a circular plate on which a set of three fixed blades and scooping blades are provided and another plate with three fixed blades is fixed at the top. The device can be easily operated by any unskilled person. It requires less effort to dehusk the coconut using this device when compared with the conventional method. It can be fabricated locally. It is simple in design and safe to operate. The out turn of this machine is 110 nuts/hr whereas the outturn by traditional way is about 160nuts/hour. But the main advantage of this machine is that an unskilled man can do this job with out the risk of injury.

Power Operated Coconut Husking Machine:

A power operated semi automatic coconut husking machine has been developed (CPCRI, 1996). The machine consists of three main parts viz., a rotating platform having a set of six coconut holders, a piercing system with shock absorber to avoid breakage of coconut due to excess load and a scooping blade set for splitting and loosening the husk. The required operating speed of various parts is achieved by using different types of gearboxes. The machine can dehusk 500-600 nuts/hour much higher than the traditional spike method. Two unskilled laborers are required to operate this machine. It is economical and financially beneficial to farmers and copra manufacturers. The time required to dehusk one nut is six seconds.

Copra dryers:

Drying is an important post-harvest operation in the processing of coconut for the extraction of oil. For the efficient storage of copra and easy extraction of oil, fresh coconut meat, which contains 45 - 55 per cent moisture, has to be dried to 5 - 6 per cent moisture level to obtain the copra. The conventional system of copra drying is by spreading the split coconuts on an open surface for sun drying. This operation takes 6-8 days and quality deterioration due to deposition of dirt and dust of wet kernel is unavoidable. Moreover, if the atmosphere is cloudy and the temperature goes down during the initial days of drying, the copra will get infested with mould. The direct-type kiln dryers are not desirable for copra as the copra becomes inferior in quality due to the smoking and improper drying.

Studies on vacuum drying of desiccated coconut:

The drying characters of the desiccated coconut in vacuum dryer was studied (TNAU, 1996). Good quality desiccated coconut can be obtained by drying in the vacuum dryer at 100°C in 200 mm of Hg vacuum. The drying time is reduced, in vacuum drying to 20 minutes instead of 40-50 minutes in conventional forced hot air drying. The colour and quality of the product is also very good. Due to vacuum, puffing of the desiccated coconut (about 40%) was also observed in vacuum drying.

Preparation of ball copra by heat treatment:

The conventional way of preparing ball copra is by storing the fully matured coconuts on a raised platform inside a shed or attic for a period of nine to twelve months. In order to reduce this incubation period to the minimum, a new processing was

developed (Madhavan, 1993). Coconut is partially dehusked and heated in the CPCRI Small Holder's Dryer at 55 - 60° C for eight hours daily for three days and stored in gunny bags for 10 days. This intermittent heating was repeated till all the nuts became ball copra. All the nuts under heat treatment became ball copra within six months and the quality of the ball copra was also very good. In control, it took 11 months.

Study on storage of copra and coconut oil:

The storage life of copra and coconut oil was studied by the addition of fumigants, preservatives and antioxidants in selected storage structures (Chempakam, et al., 2000). It was recommended from the study on storage of copra on various storage containers with various fumigants and gases that copra could be stored for more than 6 months by exposing it either to bio-gas for 1 to 3 days or to neem leaf gas for 15 days immediately after splitting prior to storage in any air-tight container. To optimize the shelf life of coconut oil, various additives like citric acid 500 ppm, tamarind powder of 2 per cent, common salt of 1 per cent and sodium metabisulphate of 500 ppm were tried. The first three treatments were effective in retaining the quality of oil. The study on the storage of coconut oil in various containers with various anti oxidants/preservatives revealed that the storage of oil in air-tight brown coloured containers along with either sodium meta bisulphate, citric acid or common salt will increase the shelf life of the oil for more than six months. Samples kept after infusion of neem leaf gas and SO_2 to the saturation point had lower population of fungi and bacteria, as reflected in the quality of the oil.

Chemical treatment of fresh kernel:

Preservation of fresh kernel is essential when drying is delayed due to uncertainty of weather conditions. Chemical treatment of dipping fresh kernel in 1000 ppm propionic acid for 60 minute to preserve it upto 49 days without further drying had been developed (Patil, 1980).

Copra moisture meter:

For safe storage of copra (dried coconut kernel), its moisture content should be less than 6 percent. For a rapid and accurate measure of the moisture content, an electronic moisture meter was developed on the principle of electric conductivity (Madhavan, 1986). It consists of an electronic unit, an output meter and a sensor. The sensor is made of a pair of steel rods of size 8 mm X 2 mm fixed 6 mm apart. The Power Supply is 9V Eveready 216 Battery or equivalent. It can read moisture content from 5% to 40%. After switch on the instrument adjust the Cal.Pot so that the meter needle rests on the 'Cal' position marked on the dial. Then, plug the sensor into the sensor socket. Probe the sensor into the inner side of the coconut kernel (copra). The reading now seen on the meter gives the percentage moisture content in the copra. The instrument is handy and useful to copra processors and farmers. This unit has been marketed by M/s Kerala Agro Industries Corporation in view of its practical application.

Coconut kernel based value added products:

Coconut kernel contains almost all essential vitamins and minerals, which are necessary for health. It is mainly used in house as well as in food industries.

<u>Optimization of modified atmosphere packaging parameters for coconut fresh kernel:</u>

Preservative mixture of butylated hydroxy anisole @ 0.1% and propionic acid @ 1000 ppm was found to increase the shelf-life of kernel along with MAP system. At 15°C storage temperature, low density polyethylene film of thickness 0.041 mm and polypropylene film of 0.042 mm thickness and at 25°C storage temperature, low density polyethylene film of 0.027 mm thickness, were found to be the best for modified atmosphere package (Bosco, 1997 and Bosco and Kaillapan, 2000). The shelf-life of the kernel in MAP was increased to minimum period of 90 and 25 days. For vacuum package, polypropylene film of 0.042 mm thick film was the best to store at both 15 and 25°C. The shelf-life of the kernel was increased to minimum period of 60 and 20 days at

15 and 25°C, respectively. The shelf-life of the kernel stored in open condition at 15 and 25°C was only 20 and 5 days, respectively.

Sweet coconut chips:

Intermediate moisture coconut kernel is the mature coconut kernel after removing the moisture content of the kernel partially by osmotic dehydration by using osmotic mediums like sugar syrup. This dehydrated coconut slices of osmotically dehydrated coconut slice is named as "Sweet Coconut Chips". A technology for the production of sweet coconut chips has been developed (Bosco, S.J.D and K.U.K. Nampoothiri, 2000 a). Sweet Coconut Chips is crispy and can be packaged and marketed in laminated aluminium pouches, which will have shelf-life of 6 months. Since it is in ready-to-eat form, it could be used as snake at any time. It could also be used just like fresh kernel after rehydration of the chips in hot water.

Microstructure of Spray dried and Partially Defatted Coconut Skim Milk powder:

The microstructure of coconut skim milk powder was observed using scanning Electron Microscopy (SEM). Small surface folds and cracks were noticed in some particles, whereas many samples contained small depressions, resembling the surface of moon. The surface of particle looked like honeycomb structure. Some of the particles were more wrinkled and curly (Ganesan, V and L. Gothandapani, 1999).

Investigations on production of coconut skim milk powder:

An attempt has been made to explore the possibilities of spray drying of coconut skim milk powder to produce coconut skim milk powder (CSMP) (Ganesan, V and L. Gothandapani, 1998). The critical operations involved to produce C S M P were identified as centrifuging, evaporation and spray drying. The coconut milk could be successfully spray dried in a spray drier. The characteristics of the product was comparable with commercially available product. The slim milk had a bulk density of 0.5 g/cc with a moisture content of 3.00 percent and with an ash content of 8.00 percent. The product could be successfully stored under vacuum at refrigerated storage 15-20 degree centigrade for more than two months.

Tender coconut water based value added products:

In India, annual consumption of tendernuts is about 200 million. Tendernuts are valued both for sweet water, which is a refreshing drink, and its gelatinous kernel which is a delicious food. Moreover, the tendernut water has a number of medicinal properties and it is an essential component in many of the ayurvedic preparations. It increases the

blood circulation in the kidneys and causes profuse dieresis.

Snow ball tender coconut:

The tender coconut kernel is good for convalescing patients. It contains good amount of nutrients. An attempt was made to supply the tender coconut water along with tender coconut kernel without any waste material being thrown away after consumption. Thus, a technology for making snow ball tender nut (SBTN) has been developed (Bosco, S.J.D and K.U.K. Nampoothiri, 2000 b). SBTN is the tender coconut without husk, shell and testa which is in ball shape and white in colour. This white ball will contain tender coconut water, which can be consumed by just inserting a straw through the top white tender coconut kernel. Making groove in the shell before scooping out the tender kernel with water is the one of the important unit operation. For this a suitable machine has been developed. It is nutritive and is a drink and a snack at the same time. Since there is no refuse after the consumption, there is no scope for littering of the premises.

Tender Coconut Punch with Cutter:

A tender coconut punch and cutter for extracting liquid and solid endosperm was developed (Jippu Jose, 1998). The punch assembly consists of vertical stainless steel punch sliding in a sleeve and operated by a second order lever. The punch is lowered and a hole is punched in the coconut through which the water is taken out. The maximum force required to be applied at the handle is 78 Kg for a coconut of 6 months maturity and 109 Kg for 8 months maturity. In order to extract the solid endosperm for consumption after the liquid is drawn out, the coconut is to be spit into two halves. The splitter assembly consists of a pedestal a curved serrated knife and swinging handle. The coconut is placed as the base and knife is lowered splitting the coconut husk till the knife reaches the shell. Then, the handle is given a sudden jerk to rip open the shell. This cuts the coconut into two halves.

Waste utilisation:

Utilization of coconut pith for biogas production:

The possibility of utilizing pith for biogas production was studied in the field using $2m^3$ Khadi and Village Industries design biogas plants (Vidhan Singh, et al., 2000). Coconut pith in combination with cowdung gives higher methane content biogas, while alone it does not produce any gas. The best combination is to be with 80% cowdung and 20% coconut pith. The methane percentage was about 11 % more in the treatment 80%

cowdung and 20% coir pith as compared to the control where as in all the other treatments the methane percentage was lower than the control.

Utilization of coconut pith as fluidised fuel:

Dried coconut pith could be blown with air to burn in suspension using a blower. A fluid furnace using pith has been developed (CPCRI, 1999). The air kept the pith rotating in circular motion and the large particles are thrown outwards by the centrifugal force and burn near the walls while the smaller particles burn in suspension in the air. The exhaust temperature was about 380^0 C. The temperature around the furnace was about 85°C, which will be used to dry pith. 400 nuts Copra dryer has been developed which can be connected to the fluid furnace. The highest furnace efficiency obtained was 80 % at the pith feed rate of 10 kg /hr and air flow rate of 87.6 cum/hr.

Preservation of coconut timber:

An attempt was made to find the most suitable preservation technique and to select the best preservatives with respect to the various end use of the treated wood (Mathew, et al., 2000). The methods tested for applying the preservatives are brushing or spraying, dipping, soaking/steeping, dip diffusion, double diffusion and hot and cold bath method. The wood preservatives used were Copper Chrome Boron, Copper Chrome Arsenate, Zinc Chloride + Pot. Dichromate, Boric Acid + Borax, Copper Sulphate Potassium Dichromate + Arsenic Pentoxide, Cashew Nut Shell Oil and Creosote with bunker oil.

Fuel briquettes by using tender coconut husk and shell:

Process for the production of the fuel briquette with different composition of pith and shell powder of tender coconut husk has been developed (CPCRI, 2000). Fuel briquettes were produced in the commercially available briquette machine and the analysis of its characters is under progress.

Utilization of coir pith as Composting:

Application of fresh coir pith as a manure to the crops is not advisable due to its higher C: N ratio of 112:1. The direct application of un-decomposed coir pith resulted a reduction in soil microbial population soil dehydrogenases and soil respiration in all soils. A technology has been developed at Tamil Nadu Agricultural University using Basidiomycetous fungus, *Pleurotus sajor,* Caju, which is capable of detoxifying

phenolics of coir pith and producing bio-polymerizing enzymes. To compost one tonne of coir pith five spawn bottles (one spawn bottle contains 350 g of Pleurotus fungus culture raised on sorghum or pearl millet grain) and five kg of urea are required. By this process, coir pith compost with a C: N ratio of 24:1 is formed within a period of 35 days.

Densification of coir pith:

Tamil Nadu Agricultural University has developed (Varadaraju and Gothandapani, 1998) a pelletizer for making pellets from decomposed coir pith. The unit is operated by a 5 hp electric motor and has a capacity of 100 kg/h of extruding the pellets of 6 to 8 mm diameter and 10 to 12 mm length at 25% moisture content. The coir pith pellet with optimum durability, compaction and expansion ratios of 0.82, 3.14 and 1.33 respectively obtained.

Briquetting:

A continuous extruder type briquetting machine, consisting of screw shaft, barrel housing, extruder die pipe and gear box has been developed at Tamil Nadu Agricultural University with a capacity of 125 kg per hour (Devadas, 1996). Briquettes produced from coir pith using cow dung or molasses as binder has the calorific value of 3000 to 3200 kcal/kg, used as an alternative source of fuel.

Building Materials:

A technology for the production of coir-cement corrugated roofing sheet ahs been developed by the Tamil Nadu Agricultural University (Viswanathan, 1998). It is observed that the temperature is lowered by 1 to 4^0 C in coir-cement corrugated roofing than in asbestos. Lightweight bricks using coconut pith in the proportion of upto 80:20 (clay and pith) by weight is found successful (Dan, 1993). Medium density. Particle boards of size 25 cm X 25 cm using coir pith with phenol formaldehyde and urea formaldehyde as binder is produced. The strength characteristics of the boards were on par with other commercial boards (Vuswanathan, 1996). However the water absorption and swelling characteristics are high which are not desirable for use in external applications.