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Coconut

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2.1 INTRODUCTION

The coconut palm exerts a profound influence on the rural economy of the many states where it is grown extensively and it provides sustenance to more than 10 million people. The export earnings derived by India from coconut are around Rs. 13,370 million. The processing and related activities centred on the crop generate employment opportunities for over two million people in India. As an oilseed, coconut holds 15.2% share of the total oilseed value output in the country.

The coconut palm is mainly grown in ecologically sensitive areas such as coastal belts, hilly areas and areas with high rainfall and humidity. Undertaking farm operations in these terrains is cumbersome. Moreover coconut is a tall tree and hence, coconut harvesting, crown cleaning and other operations involve skilled laborers. Non-availability of skilled laborers in addition to the fluctuating prices is the major challenge in coconut cultivation. Therefore, it is envisaged that the future of coconut industry lies in its mechanization. Through the concerted efforts of research over the years, various coconut mechanization, post harvest processing and water management techniques are developed. Further, mechanization in coconut has gained popularity among farmers for its multi-dimensional benefits such as reduction of operational costs and human drudgery, timeliness of operation, increased labor productivity and efficiency. There also exists a huge scope for coconut based agribusiness in India with reference to processing and value added products. In this book, the various technologies available for mechanization, water management and post harvest processing are discussed.

2.2 PRE-HARVEST MECHANIZATION

Tools and equipment for land development

Land development is the costliest operation in farming, especially when the terrain is undulating as is the case of majority of the plantations. Land development

is essential for soil and water conservation and to mechanizing intercultural and other farming operations. It involves jungle clearance, soil opening with deep tillage equipment, moving soil from high to low spots, making farm roads, field bunding and levelling, etc. These operations require use of self propelled and heavy equipment such as crawler tractors with heavy duty ploughs and dozers, high horse power tractors with dozing arid hoeing attachment, scrapers, ditchers, chisel ploughs, subsoilers, terracers, levellers, etc.

2.2.1 Backhoe Dozer

These are attachments of tractor. The dozer is mounted in front of the tractor and backhoe (Fig.2.1) in the rear. The dozer and backhoe can be easily removed and joined to the tractor. The dozer consists of a thick curved plate and hardened strip. The strip has sharp cutting edge and is joined to the curved plate of the dozer with fasteners. Therefore, the strip can be replaced on wearing or becoming blunt. The dozer plate is joined to the tractor with sturdy arms and can be raised or lowered with hydraulic system of the tractor. Backhoe consists of a bucket with digging fingers, hydraulic cylinder, arms and base for attaching to the rear of the tractor. The bucket position is manipulated by hydraulic system. The digging fingers are hardened and can be replaced on wearing or becoming blunt. The Backhoe of the machine would be very much useful to taking pits for planting coconut seedlings. The Dozer in turn would be used for clearing the jungle and levelling the land especially prior to planting coconut.



Fig.2.1: Backhoe Dozer

(Source: http://bullindia.com/tractor-attachments/products_back.html accessed on 17.03.2016)

2.2.2 Backhoe Loader

These are also attachments of tractor. The loader is mounted in front of the tractor and backhoe at the rear (Fig.2.2). The loader and backhoe can be easily removed and joined to the tractor. Backhoe consists of a bucket with digging fingers, hydraulic cylinder, arms and base for attaching to the rear of the tractor. The bucket position is



Fig.2.2: Backhoe Loader

(Source: http://bullindia.com/tractor-attachments/products_back.html accessed on 17.03.2016)

manipulated by hydraulic system. The digging fingers are hardened and can be replaced on wearing or becoming blunt. Loader consists of curved frame in the front, which acts as bucket, arms hinged to each other by pins, hydraulic cylinders and hydraulic system. The loader, therefore, can be maneuvered to the required position through hydraulic controls.

Loader is used for removal of mud and loose soil or loading of loose soil and boulders into the dumpers and trailers during land preparation prior to coconut planting. Backhoe is used for making pits for coconut planting, excavating soil, making foundation, taking trenches for pipe and cable laying for irrigation, widening of rural roads and removal of bushes and trees etc.

2.2.3 Tractor Mounted Terracer Blade

It is attached to the tractor with the 3-point linkage (Fig.2.3) system and is hydraulically controlled. It consists of replaceable blade attached to curved steel body, side wings and indexing arrangement for tilting and angling of the blade. The cutting blade is made of medium carbon or alloy steel and the cutting edge is hardened and sharpened. The blade with body is also called mould board. The mould board can be angled left or right by lifting the



Fig.2.3: Tractor Mounted Terracer Blade
(Source-<http://www.agro-implements.com/terracer-blade-land-leveller.html> accessed on 19.03.2016)

spring loaded latch pin and by turning the mould board. To tilt the blade for ditching or terracing the blade is tilted to the desired angle by moving the index pin. The depth of cutting is controlled by hydraulic system of the tractor. It can be reversed for back filling. For increasing the length of blade, extensions are provided.

2.2.4 Hydrodozer

This is a tractor front mounted dozer (Fig.2.4). The dozing blade assembly consists of a curved plate (bucket) to which cutting blade made of hardened alloy steel is joined with dozer arms, hydraulic cylinders, frame and body. The cutting blade edge is sharp and fastened to the plate with fasteners. The blade is reversible type. The dozer is hydraulically controlled.



Fig.2.4: Hydrodozer
(Source-http://bullindia.com/tractor-attachments/products_back.html accessed on 17.03.2016)

2.2.5 Hydraulic Scraper

The hydraulic scraper (Fig.2.5) is towed behind the tractor. The scraper consists of cutting blade, hydraulic system, hitch point, hitch bar, apron, bowl, wheels, apron cylinder, side frame, bucket cylinder, spring, and sidearm. The scraper working is controlled by the hydraulic arrangement. The blade is made of alloy steel and has self-sharpening tungsten carbide cutting edge. For operation, the scraper is attached to the tractor, hydraulic system connected and apron is raised. With the forward movement of the tractor, the blade penetrates into the soil and bucket bowl gets filled. The apron is closed after the bucket is filled and the scraper is moved to the point of unloading. For unloading, the bucket is tilted hydraulically.



Fig.2.5: Hydraulic scraper
(Source-http://bullindia.com/tractor-attachments/products_back.html accessed on 17.03.2016)

2.2.6 Bullock Drawn Land Leveller

The bullock drawn land leveller (Fig.2.6) is fabricated from steel sheets and two handles are fixed to it with the help of fasteners. Mild steel round bar is bent to a suitable shape with holes at its extremities for fixing to the scraper. This steel round has a semi-circular loop to which the rope from the yoke of the animal can be attached for towing. One pair of animals is required to operate the implement. The levellers are of different design and shape, but the scoop type and terrace blade type are most common. The leveller is used for filling in or depression and levelling minor irregularities in the field.



Fig.2.6: Bullock drawn land leveller
(Source-<http://www.fao.org> accessed on 21.03.2016)

2.2.7 Land Leveller

It is a tractor-mounted implement controlled by tractor hydraulics and three-point linkage. It consists of hitch system, replaceable cutting blade with sharp edge, and a curved plate with side wings, which form a bucket (Fig.2.7). The blade is made from medium carbon steel or low alloy steel, hardened and



Fig.2.7: Land leveller
(Source-<http://www.agro-implements.com/terracer-blade-land-leveller.html> accessed on 21.03.2016)

tempered to suitable hardness. During operation, the blade digs into the soil and extra soil is collected in the bucket, which is released in the depressions of the field. The angle and pitch of leveller is adjustable. The leveller can also be angled left or right, or reversed for back filling.

2.2.8 Laser Land Levelling

Traditionally farmers level their fields using animal drawn or tractor-drawn levellers. These levellers are implements consisting of a blade acting as a small bucket for shifting the soil from higher to the low-lying positions. It is seen that even the best levelled fields using traditional land levelling practices are not precisely levelled and this leads to uneven distribution of irrigation water. The common practices of irrigation in intensively cultivated irrigated areas are flood basin and check basin irrigation systems. These practices on traditionally levelled or unlevelled lands lead to water logging conditions in low-lying areas and soil water deficit at higher spots.

The advent of the laser-controlled land levelling equipment (Fig.2.8) has marked one of the most significant advances in surface irrigation technology. It has four essential elements: (1) the laser emitter; (2) the laser sensor; (3) the electronic and hydraulic control system; and (4) the tractor and grading implement.

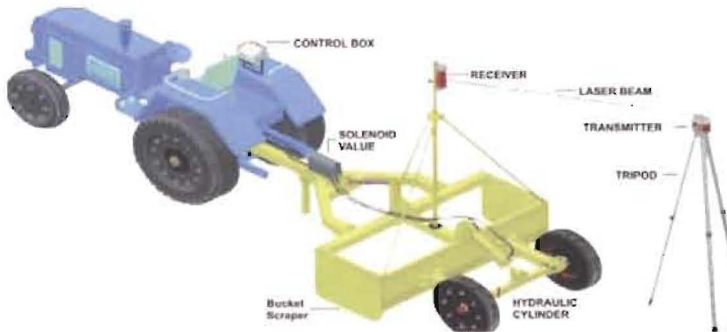


Fig. 2.8: Laser land levelling

(Source: <https://shivkumardas.wordpress.com/agri-tech/laser-land-leveler> accessed on 23.03.2016)

The laser emission device, involves a battery operated laser beam generator which rotates at relatively high speed on an axis normal to the field plane. This rotating beam thereby effectively creates a plane of laser light above the field which can be used as the levelling reference rather than the elevation survey at discrete grid points in conventional land levelling techniques. The distance between the laser beam and the earth surface is defined such that deviations from this distance become the cuts and fills. With laser systems, there is little or no need for the exhaustive engineering calculations of the conventional approach.

The cost of levelling is usually contracted on the basis of money per equipment hour. The laser emitter is generally located on a tripod or other tower-like structure on or near the field and at an elevation such that the laser beam rotates above any obstructions on the field as well as the levelling equipment itself. The beam is targeted and received by a light sensor mounted on a mast attached to the land grading implement. The sensor is actually a series of detectors situated vertically so that as the grading implement moves up or down, the light is detected above or below the centre detector. This information is transmitted to the control system which actuates the hydraulic system to raise or lower the implement until the light again strikes the centre detector. It is in this manner that the sensor on the mast is continually aligned with the plane on the laser beam and thereby references the moving equipment with the beam. It is important to note that the sensitivity of the laser sensor system is at least 10 to 50 times more precise than the visual judgement and manual hydraulic control of an operator on the tractor. Consequently, the land levelling operation is correspondingly more accurate. The skill of the operator is substantially less critical to the levelling which allows farmers and other personnel access to the land grading equipment (Fig.2.9).



Fig.2.9: Land grading equipment
(Source: <https://shivkumardas.wordpress.com/agritech/laser-land-leveler> accessed on 23.03.2016)

2.2.9 Device for Pit Making

Coconut seedlings are planted in a pit of 1m x 1m x 1m dimensions. Traditionally it is done by manual digging. Now a day's excavators are very commonly used for this purpose. However, accessibility of excavator is a limiting factor where the topography is undulating and is terraced. A tractor PTO operated screw type digging device developed at ICAR-Central Plantation Crops Research Institute (CPCRI) could be of great help for farmers in such pit making operation. This can make a pit of 90cm deep and 30 cm diameter. The farmer can take four pits and manually remove the remaining soil in between the pits there by creating a pit of approximately 1 cubic metre required for coconut planting.

2.3 IRRIGATION

Irrigation is the one area where coconut farmers have been enjoying the benefits of mechanization to a great extent. An adequate water supply is important for coconut that produces an inflorescence every month of the year. When rainfall is not sufficient followed by long dry spell the coconuts must receive additional water through irrigation. Various methods can be used to supply irrigation water to the coconut. Each method has its advantages and

disadvantages. These should be taken into account when choosing the method which is best suited to the local circumstances.

A simple method followed by farmers before mechanizing irrigation was to physically bring water from the source of supply to each coconut. Sophisticated methods of water application came after the invention of power operated irrigation pumps. There are three commonly used methods: surface irrigation, sprinkler irrigation and drip irrigation.

2.3.1 Flood Irrigation

In surface irrigation water is first lifted to a higher elevation and is allowed to flow over the surface of the coconut field. Either the entire field is flooded or the water is fed into small channels (furrows) or strips of land (borders). Flood irrigation should be done only under conditions of ample water availability. It can also be done only on flat land. The advantages are the low technical skills required and low investment costs. Disadvantages are the difficulty in controlling of the volume of water applied, increased leaching of nutrients and discontinuity of water application. The water requirement for this method is high as considerable amount of water is lost due to soil absorption, leaching, and evaporation. This method is particularly not suitable for sandy soils due to heavy losses of water by percolation. Furthermore, it is difficult to apply a fixed volume of water to a palm by this method.

2.3.1.1 Basin Irrigation

A basin of shallow depth (about 10 cm) is prepared around the base of the palm, and the basins of adjacent palms are interconnected with furrows. Water is allowed to flow freely from the furrows to the basin (Fig.2.10). This method is not suitable for undulating lands. Even in flat lands, considerable land preparation is required initially to allow free flow of water.

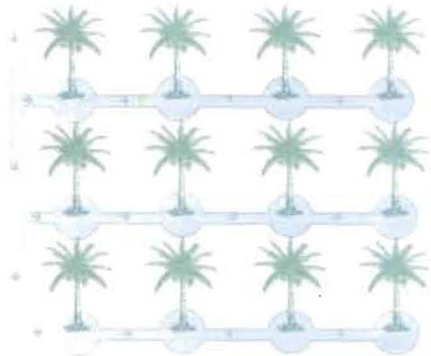


Fig. 2.10: Basin irrigation

2.3.1.2 Hose Irrigation

Hose irrigation is a type of basin irrigation where water is brought from the source to the coconut basin through conduit pipes there by reducing the transportation loss to very minimum. An underground poly vinyl chloride (PVC) pipes network to supply water to outlets is more suitable for coconut plantation. One inch diameter and 30 m long rubber hoses are used to irrigate 16 palms within the one outlet. This would facilitate other practices in the estate such as weeding, picking and transport of nuts. Also it facilitates to irrigate intercrops and maintenance is very easy and profitable. The pipe system consist main line, sub main line and risers. At the end of each riser, 2.5 cm ball valves are installed to deliver water to palms. Application of 200 litres of water once in four days was recommended for irrigating coconut palms by basin irrigation method.

2.3.2 Sprinkler Irrigation

Sprinkler irrigation or perfo sprays are more suited to inter or mixed cropping systems where the entire surface requires wetting. The quantity of water applied should be at least 75 per cent of open pan Evaporation (Eo). Sprinkler irrigation or perfo irrigation with 20 mm (IW/CPE=1) water was found to be the best suited to coconut inter or mixed cropping systems where the entire surface requires wetting. Sprinkler irrigation is similar to natural rainfall. Water is pumped through a pipe system and then sprayed in the coconut garden through rotating sprinkler heads (Fig.2.11).

A typical sprinkler irrigation system consists of the following components:

- Pump unit
- Mainline and sometimes submainlines
- Laterals
- Sprinklers

The pump unit is usually a centrifugal pump which takes water from the source and provides adequate pressure for delivery into the pipe system. The mainline and submainlines are pipes which deliver water from the pump to the laterals. In some cases, these pipelines are permanent and are laid on the soil surface or buried below ground. In other cases, they are temporary, and can be moved from field to field. The main pipe



Fig. 2.11: Sprinkler Irrigation



Fig. 2.12: Sprinkler

(Source: <http://www.jains.com> accessed on 25.03.2016)

2.3.3 Drip Irrigation

With drip irrigation, water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers which are located within the basin of coconuts. Only the immediate root zone of each coconut is wetted. Therefore, this can be a very efficient method of irrigation. Application of 200 litres of water once in four days is recommended for irrigating coconut palms by basin irrigation method, where as drip irrigation @ 66 % of the open pan evaporation from December to May is ideally suited for coconut resulting in 34 per cent saving of water. Fertilizer saving through drip fertigation i.e., 50% of the recommended dose of fertilizer when applied through drip fertigation is sufficient to give a yield equivalent to 100 % of the recommended dose of fertilizer. Fertilizers viz., 70g Urea, 60g DAP and 170g Muriate of Potash are recommended for a single dose for one palm. A total of 7 times the fertigation can be applied through drip irrigation. For phosphorus application, commercial phosphoric acid also can be used.

2.3.4 Fertigation

Fertigation is an efficient method of fertilizer application through drip or any other system of irrigation. Drip fertigation helps to increase the fertilizer use efficiency, make savings in fertilizer costs, reduce labour requirement, enables uniform, precise and direct application to root zone and correction of micronutrient deficiencies etc. Soluble fertilizers viz., urea (for nitrogen), DAP (for phosphorus and nitrogen) and Muriate of potash (for potassium) can be combined and supplied through drip irrigation, after filtering the solutions before adding to the fertilizer tank. The other possibility is to use liquid fertilizers, which are highly soluble and hence there is no clogging problem. But these are costly. Fertigation can be done using a fertigation tank or venturi system. The fertilizer should be applied in the active absorption zone for which the emitter should be placed 1 m away from the bole of the palm. Compared to conventional method, we can save fertilizers up to 50 per cent because of the higher fertilizer use efficiency.

2.3.5 Irrigation Equipments

Irrigation system installations consist of various pipes, fittings, valves and other equipment depending on the kind of irrigation system and the type of installation.

Irrigation equipment can be divided into:

- Pumping devices
- Pipes and fittings
- Flow control devices
- Water filters
- Fertigation equipment

- Emitters
- Automation devices
- Operation equipment

2.3.5.1 Irrigation Pipes

The pipes are the basic component of all irrigation networks. There are various kinds and types available in any pressure ratings and in different sizes. The pipes commonly used in irrigation systems are rigid PVC and polyethylene (PE). Quick coupling light steel pipes and lay flat hoses are also in use. Threaded galvanized steel pipes which were in use earlier are of limited use at present.

2.3.5.2 Pipe Fittings

Malleable iron threaded: These fittings are made for use with galvanized steel threaded pipes. They are available in a wide range as elbows, bends, reducers, tees, plugs, nipples and other.

Polypropylene (PP) pipe connector fittings: Polypropylene connector plastic pipe fittings (Fig. 2.15) (joints) are mainly suitable for use with PE plastic pipes.

PVC fittings: Pipe fittings made of PVC (Fig.2.16) are available in the same dimensions as that of metal pipes and fittings. They are manufactured for solvent welding, threaded jointing and for push-fit integral mechanical jointing.

2.3.5.3 Flow control devices

These are devices installed in the supply system, in order to ensure that water reaches the desired destination, at proper time, in the required amount, and under the right pressure. Water control devices can be divided into three main classes



Fig. 2.15: Polypropylene Pipe fittings
(Source: <http://www.jains.com> accessed on 25.03.2016)



Fig. 2.16: PVC Pipe fittings
(Source: <http://www.jains.com> accessed on 25.03.2016)

2.3.5.4 Directional Devices or Valves

They regulate the water flow. Installed in the pipeline, they enable starting or stopping the flow, and setting its rate, pressure and direction. Examples of such devices are the stop valves, the check valves and the regulating valves (Fig. 2.17).



Fig. 2.17: Flow regulating valve
(Source: http://www.cla-val.com/waterworks-valves-c-1_11-l-en.html accessed on 22.03.2016)

2.3.5.5 Measuring Devices or Valves

In order to ensure the appropriate flow regime, just regulating the flow is not enough. It is also necessary to obtain accurate information about flow parameters, so that adjustments can be made, as required, to achieve the desired flow conditions. Water flow meters (Fig.2.18) and pressure gauges (Fig.2.19) belong to this group.



Fig. 2.18: Water flow meter
(Source: http://www.cla-val.com/waterworks-valves-c-1_11-l-en.html accessed on 22.03.2016)



Fig. 2.19: Pressure gauge
(Source: http://www.cla-val.com/waterworks-valves-c-1_11-l-en.html accessed on 22.03.2016)

2.3.5.6 Auxiliary Devices

These do not directly influence fluid flow, but ensure an undisturbed functioning of a system. Air valves (Fig.2.20) and safety valves (Fig.2.21) belong to this group.



Fig. 2.20: Air valve

(Source: http://www.cla-val.com/waterworks-valves-c-1_11-l-en.html accessed on 22.03.2016)



Fig. 2.21: Safety valve

(Source: http://www.cla-val.com/waterworks-valves-c-1_11-l-en.html accessed on 22.03.2016)

2.3.5.7 Shut-off valves or stop valves

They are the most widely used valves and are manually operated. They serve to start or stop the flow of water in the pipeline. The most common are the gate (Fig.2.22), ball, butterfly, radial and disk valves. In gate valves, the water moves in a straight line without resistance when fully open.

2.3.5.8 Check valves

Check valves, also called non-return valves (Fig. 2.23), permit flow in one direction only and prevent reversal flow in the pipe network by means of an automatic check mechanism. They come in two basic



Fig. 2.22: Gate Valve

(Source: http://www.cla-val.com/waterworks-valves-c-1_11-l-en.html accessed on 22.03.2016)



Fig. 2.23: Non return valves

(Source: http://www.cla-val.com/waterworks-valves-c-1_11-l-en.html accessed on 22.03.2016)

types: the swing check, which can be installed in horizontal or vertical piping; and the lift check, for use in horizontal lines only. Water flow keeps the check valves open, and gravity and reversal of flow close them automatically.

2.3.5.9 Water Meters

Water meters measure and record the volume of water passing through them, without considering the time element.

2.3.5.10 Pressure Gauges

Measurement of pressure in key points of a network is important for water system operator. The pressure gauge should be installed in easily accessible places, so that it is convenient to read and to maintain. The most common pressure gauge used in water supply and distribution service is the 'Bourdon gauge'.

2.3.5.11 Air Valves

They protect the pipe network from damage by trapped air in the system or from collapse due to a vacuum.

2.3.5.12 Safety Valves

Safety valves are also called pressure relief valves. It is used mainly to ensure proper working of an irrigation system in cases of failure of other pressure control devices. When the pressure in the system exceeds the pre-set value, the valves open and release water into the air. Thus, they prevent the pipes from bursting due to sudden high pressures which might occur in the system.

2.3.5.13 Filters

The filtration of the irrigation water is essential to avoid blockage in emitters. The type of filter used depends on the kind of impurities contained in the water and the degree of filtration required on the emitters.

2.3.5.13.1 Gravel filters

These filters, also called media filters (Fig.2.24), are closed cylindrical tanks which contain either a gravel grain of 1.5-3.5mm or a basalt sand filter bed. Where the irrigation water source is an open reservoir, they are installed at the beginning of the head control of the system. Water is entering the tank from top passes through the gravel bed, which traps the large particles of unbroken organic matter, mostly algae, and exits through the outlet at the bottom of the tank. They are equipped with the necessary inlet, outlet and drain valves, and a back-flushing arrangement.



Fig. 2.24: Gravel filter
(Source: <http://www.jains.com>
accessed on 25.03.2016)

2.3.5.13.2 Hydrocyclone (sand separator) filters

These are closed conical metal tanks placed at the beginning of the head control unit of the irrigation system (Fig. 2.25). They separate sand or silt from well or river water through the creation of a centrifugal force by a vortex flow inside the filter. This force drives the solids downward to a collecting chamber attached below and lets the clean water out.

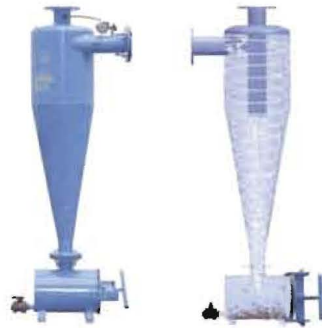


Fig. 2.25: Hydrocyclone filter

(Source - <http://www.jains.com> accessed on 25.03.2016)

2.3.5.13.3 Screen type filters

Screen type filters (Fig.2.26) are equipped with interchangeable perforated filtering elements, inlet, outlet and drain valves and pressure inspection gauges. These are used for final filtration as a safeguard in case moderate quality water comes out from a primary filter. They are installed at the end of the head control before the main pipeline.

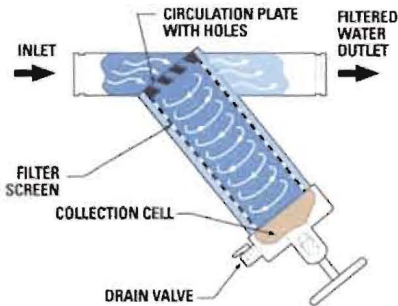


Fig. 2.26: Screen type filter

(Source: <http://www.jains.com> accessed on 25.03.2016)

2.3.5.13.4 Disk type filters

The filtering elements consist of stacks of grooved plastic rings with multiple intersections (Fig.2.27) providing a three dimensional filtration of high level. They are very effective in removing all kinds of impurities of inorganic and organic origin, including algae. They are placed at the end of the control unit before the main pipeline.



Fig. 2.27: Disk type filter

(Source: <http://www.jains.com> accessed on 25.03.2016)

2.3.5.13.5 Automatic self-cleaning filters

Most of the filters can be provided with an automatic cleaning mechanism (Fig.2.28). The cleaning mechanism is activated by sensing the pressure differential, duration of filtration, volume of water filtered, or by any combination of these. The cleaning mechanism, usually back flushing, for the removal of accumulated debris uses the system's water pressure.



Fig. 2.28: Automatic self-cleaning filters
(Source: <http://www.jains.com> accessed on 25.03.2016)

2.3.5.14 Fertigation Equipments

Fertilizers can be applied with the irrigation water using these special devices. There are three main types of fertilizer injectors: closed tank, venturi type and piston pump. All of them are water driven by the operating pressure of the system.

2.3.5.14.1 Fertigation tank

This is a cylindrical, epoxy coated, pressurized tank (Fig. 2.29), resistant to the system's pressure, and connected as a bypass to the supply pipe of the head control. It is operated by differential pressure created by a partially closed valve, placed on the pipeline between the inlet and the outlet of the tank. Part of the flow is diverted to the tank entering at the bottom. It mixes with the fertilizer solution and the diluted solution is ejected back to the irrigation system. The dilution ratio and the rate of injection are not constant. The concentration of fertilizer is high at the beginning and very low at the end of the operation.



Fig. 2.29: Fertigation tank

(Source: <http://www.jains.com> accessed on 25.03.2016)

2.3.5.14.2 Venturi type

This is based on the principle of the venturi tube (Fig.2.30). A pressure difference is created between the inlet and the outlet of the injector by connecting it to a bypass arrangement. The fertilizer solution placed in an open container is sucked through a tube connected to the venturi. They are cheaper than the other injectors.



Fig. 2.30: Venturi type

(Source: <http://www.jains.com> accessed on 25.03.2016)

2.3.5.14.3 Piston pump

This type of injector (Fig.2.31) is powered by the water pressure of the system and is installed directly on the supply line. The water flow activates the pistons and the injector is operated, ejecting the fertilizer solution from a container. This can maintain a constant rate of injection. Made of durable plastic material, these injectors are available in various models and sizes. They are more expensive than the venturi type injectors.



Fig. 2.31: Piston pump

(Source: <http://www.jains.com> accessed on 25.03.2016)

2.3.5.15 Water Emitters

Fitted on the laterals at frequent spaces, they deliver water to the plants in the form of a rain jet, spray, mist, small stream, fountain or continuous drops.

2.3.5.15.1 Sprinklers

Most of the agricultural sprinklers are the hammer-drive, slow rotating impact type, single or twin nozzle. The sprinklers shoot jets of water into the air and spread it to the field in the form of raindrops in a circular pattern. They are available in various nozzle sizes, flow discharges, operating pressures and wetted diameters or diameter coverage, full circle or part circle.

2.3.5.15.2 Microsprinklers

These water emitters are small plastic sprinklers of low capacity with flow rates less than 300 litres/h. Their main characteristics are their rapid rotation, less than a minute per rotation, the very small size of the water drops and the low angle of the water jet above nozzle. They have only one nozzle, of about 2.0 mm.

2.3.5.15.3 Micro-jets and sprayers

These are small plastic emitters with a low water discharge at a low angle in the form of fine drops in a sectorial or full circle pattern. They are mainly used for tree crops. They have a small passage diameter, thus filtration of the water is essential.

2.3.5.15.4 Bubblers

Low pressure bubblers are small-sized water emitters designed for localized flood irrigation of small areas. They deliver water in bubbles or in a low stream on the same spot.

2.3.5.15.5 Drippers

The drippers are small-sized emitters made of high quality plastics. They are mounted on small soft PE pipes (hoses) at frequent spaces. Water enters the dripper emitters at approximately 1.0 bar and is delivered at zero pressure in the form of continuous droplets at low rates of 1.0-24litres/h.

2.3.5.15.6 Drip tapes

They are integrated drip lines where the drippers are built in the pipe walls at the desired spacing during the manufacturing process. They are ready-made dripper laterals with a very high uniformity of application. Drip tapes are made of low density poly ethylene (LDPE) or other soft PE materials in various diameters from 12 to 20mm.

2.3.5.15.7 Pressure compensated emitters

These emitters deliver a constant flow of water at any pressure exceeding the fixed operating one. Uniform rates of discharge are achieved along the laterals regardless of the number of emitters, spacing, length of line or elevation, where excessive pressure is available.

2.3.5.16 Automation Equipments

The main components of an automatic irrigation system are the remote control (electric) valves, the controller and the field wiring, to transmit electric power.

2.3.5.16.1 Electric (solenoid) valves

These are automatic valves which can be commanded from a distant point to turn the water flow on and off. They open and close by means of a flexible diaphragm or a piston, utilizing hydraulic pressure controlled by an electrically actuated solenoid valve mounted on top.

2.3.5.16.2 Controllers

These are automatic timing devices which supply the actuating power to operate the remote control (electric) valves, i.e. to open and close on a pre-set programme.

2.3.5.16.3 Automatic volumetric metering valves

These valves consist of a water meter, a pilot assembly and a shut-off mechanism. Once the pre-set volume of water has been delivered, they shut off automatically.

2.3.5.17 Pumps

Pumps are often classified on the basis of the mechanical principle used to lift the water: direct lift, displacement, creating a velocity head, using the buoyancy of a gas or gravity.

2.3.5.17.1 Displacement pumps

The most common and well-known form of reciprocating/cyclic are the piston-type pumps. In the piston pump, water is sucked into the cylinder through a check valve on the up-stroke, and the piston valve is held closed by the weight of water above it; simultaneously, the water above the piston is propelled out of the pump. On the down-stroke, the lower check valve is held closed by both its weight and water pressure, while the similar valve in the piston is forced open as the trapped water is displaced through the piston ready for the next up-stroke.

2.3.5.17.2 Velocity pumps

Their mechanism is based on the principle that when water is propelled to a high speed, the momentum can be used either to create a flow or to create a pressure. The reciprocating/cyclic ones are rarely used while the rotary/continuous ones are highly widespread. Where high flows at low heads are required (which is common in irrigation pumps), the most efficient impeller is an axial-flow one (this is similar to a propeller in a pipe). Conversely, for high heads and low flows a centrifugal (radial-flow) impeller is needed.

Where a higher head is needed than can be achieved with a single pump, two pumps can be connected in series. Similarly, if a greater discharge is needed, two centrifugal pumps may be connected in parallel.

2.3.5.17.3 Air-lift pumps

In an air lift pump, compressed air is blown into the well at its lowest point. The compressed air produces a froth of air and water, which has a lower density than water and consequently rises to the surface. The compressed air is usually produced by an engine driven air compressor. The main advantage of the air-lift pump is that there are no mechanical below-ground components to wear out, so it is essentially simple, reliable, virtually maintenance-free and can easily handle sandy water. The main disadvantage is, it is inefficient as a pump.

2.4. DEVICES AND GADGETS FOR PLANT PROTECTION AND ANTI-BUCKLING

2.4.1. Telescopic Sprayer

The telescopic sprayer (Fig. 2.32) comprises of two co-axial pipes of ultra-light weight (0.5 kg / metre length), which can be used to spray up to a height of 12.5 m. The pipe height can be locked at any desired level above 6 m. Marginal farmers could attach a rocker sprayer where as in large gardens, a power sprayer could be used. The telescopic pipe assembly developed by CPCRI is very much useful if the garden is of uniform size (Fig.2.33). They are lightweight and durable.



Fig. 2.32: Telescopic sprayer



Fig. 2.33: Arecanut spraying using telescopic sprayer

2.4.2. Anti Buckling Device

A serious problem often faced by coconut farmers is the buckling of heavy bunches. 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 (Fig.2.34) has been developed 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 (Fig. 2.35) of the palm either by standing on the ground. The fork end of the support-rod is inserted towards the tail end of the bunch (about one-fourth distance from the



Fig. 2.34: Anti buckling device



Fig. 2.35: Coconut bunch supporting with anti buckling device

tip) to support the peduncle. The rod is slightly lifted up and the other end of the rod is inserted in the support-clamp hole. One man can easily do the operation, and it is possible to support as many as 6 to 8 bunches at a time. Harvesting of nuts can be done without removing the support-rod by severing the nuts first and the stalk last. After the nuts from the bunch are harvested, the support-rod can be taken out and used for another bunch that might require support. As the palm grows taller, the trunk clamp has to be refixed at a higher level. Before removing the trunk-damp, which is already fixed, another is fixed above the old clamp. The bunch already under support is then provided with another support-rod and the clamp, support fixed to the new trunk-clamp. The old ones can be removed and used for some other palm. This operation may be necessary only once in two years.

2.5. COCONUT HARVESTING

A professional climber with proper training only could climb coconut tree. Due to the risk involved, nowadays very less people are coming forward to climb coconut trees. This has led to no timely harvest of matured nuts, which is very important for maintenance of productivity and quality and in case of tender nut, it has to be done at proper stages.

Attempts are also made by researchers at Tamil Nadu Agricultural University (TNAU), ICAR - Central Institute of Agricultural Engineering, Bhopal and a local fabricator at Ratnagiri to develop coconut harvesting machine based on self propelled hydraulic mast where a person goes up to harvesting coconut. However, reaching the tall coconut tree and undulating terrain limit the application of these harvesting machines apart from the high initial cost. Efforts were made by local fabricators and innovative farmers also to make prototype of a 'robotic type' coconut harvester where the machine itself climbs the tree and harvest coconut. One model developed by Sri. Prakashan from Kozhikode is one such model demonstrated at several parts of Kerala. However, none of these machineries is yet to fit for commercial use.

2.5.1 Tractor Operated Multi-purpose Hoist

TNAU has developed a tractor operated multi-purpose hoist that is amenable for fruit plucking, coconut harvesting, training, pruning, lopping and spraying tree crops. The equipment is attached to the back of a 45 hp agricultural tractor. Two labourers can stand on the platform and do operations. Platform can reach a maximum height of 8.1 m.

2.5.2 Aerial Access Hoist for Coconut Harvesting

Another machine, an aerial access hoist for coconut harvesting, has also been developed by TNAU. The machine is the first machine of its kind in tractor mounted form. A full length chassis from front to rear of the tractor provides support. The entire weight of the hoist and moments transmitted through the chassis to the stabilizers without transferring to the tractor chassis. Four trees can be accessed from a single position. The time required for locating unit and operating stabilizers is one minute. The time required for positioning against a tree of 10 m height was 2 min. The positioning of the operator platform can be done by the operator himself. Lifting capacity of the machine is 120 kg.

2.5.3 Self-propelled Hydraulic Multipurpose System for Orchard Operations

Central Institute of Agricultural Engineering, Bhopal has developed a self-propelled hydraulic multipurpose system (Fig. 2.36) for orchard management operations like harvesting, pruning, spraying and other canopy management practices in fruit trees such as mango, citrus and sapota which are difficult, labour intensive and cumbersome. The machine could be used for harvesting coconut also.



Fig. 2.36: A view of harvesting of mango using CIAE developed self-propelled hydraulic multipurpose system

The self-propelled hydraulic multipurpose system has a maximum vertical reach of 6 m, has a load carrying capacity of 200 kg and can be operated at maximum ground speeds of 3 km/h. This machine was designed with dimensions of $2.2 \times 6.3 \times 1.89$ m and can be used as a platform to reach fruits on trees for easy picking. It is hydraulically powered using by 8.2 kW (11 hp) engine and has a low centre of gravity while still maintaining good ground clearance (290 mm) for good stability during operation. Lifting, lowering of the platform, forward and backward movement, and steering of the machine are controlled by the operator from the platform itself. The hydraulic system of the

machine has been designed to stop the movement of machine even if the engine needs to be shut-off. The machine is easy to operate and requires low maintenance. The fuel consumption during harvesting of mango was observed to be 2 l/h. The operator was able to pick 700-1100 mangoes/ h depending upon the fruit density on to the tree. The overturning of the machine was not observed up to its designed height of 6 m from ground with 200 kg load in the lifting platform for harvesting of mango in the orchards. The cost of unit is Rs 7.5 lakhs.

2.5.4. Ultra Lightweight Coconut Harvester

The harvester developed by CPCRI comprises (Fig.2.37) of two co-axial pipes of ultra-light weight (0.5 kg /m), which can be used to harvest up to a height of 12.5m (40ft) from the ground. The pipe height can be locked at any desired level above 6.25m (20 ft). On the top end of pipe a specially designed knife is fitted using nuts and bolts. The harvesting knife could be fabricated by local craftsman.



Fig. 2.37: Harvesting coconut using CPCRI light-weight coconut harvester

2.6. COCONUT CLIMBING

In addition to harvesting, various other operations like cleaning the crown, pollination, insecticide application and crown management are being neglected due to lack of climbers. Considering this scenario, various climbing devices have been developed since early 1970s. Their necessity was not felt till recently, however now there is a sudden shortage of climbers and the charges became quite expensive and hence there is a great demand for the climbing devices.

2.6.1. Coconut Climbing Devices

Various types of climbing devices like tractor operated, self propelled, manually operated and some robotic type (electronic) devices have been developed and tested for harvesting coconut by both the government and private sector (Kolhe, 2010, Kolhe and Jadhav, 2011, Sial, 1984, Shabana and Mohamad, 1993). Amongst the manual types, one model was developed by a farmer (Joseph model), another by TNAU (TNAU Model) and the third by CPCRI. Of all the manual devices, paddling type model developed by an innovative farmer (Joseph model) is the only machine commercially available and used by professional climbers.

2.6.2 Paddle Type Device

2.6.2.1 Chemberi Joseph Model

Joseph model (Fig.2.38) has got mainly two assemblies of similar

construction. The steel rope wires of both top and bottom assembly needs to be looped with the tree and locked. The user then climb on to the machine by placing one foot each on both the assemblies holding the handles provided. Standing on one assembly the user lifts the other assembly to loosen the steel rope and raise it by hand. After attaining a comfortable height, the user pushes back the assembly with foot so that it gets tightened to the tree. The user has to co-ordinate these two assemblies simultaneously by using hands and legs to climb on coconut tree. This model costs Rs. 1,500 only which is easily affordable by even small farmers. It does not require much skill and with 2 to 3 days initial training, both boys and girls can easily climb coconut tree.



Fig. 2.38: Chemberi model coconut climbing machine

While imparting training and commercializing the Joseph model of climbing machine, the only limitation felt by the climbers is the safety of climbers, in case of machine failure or from accidental falling. Recently, CPCRI has developed a safety attachment (Fig. 2.39) to this model of climbing machine. The safety device consists of a 6 mm steel rope of length slightly more than the circumference of the coconut trunk having an oval shaped loop each at both the ends. The only modification required in the climbing machine is providing two 6 mm metal (Mild Steel-MS) rings at the bottom of the handle of the right leg unit of the climbing machine. The steel rope is taken through these loops around the palm and one end of the steel rope is taken through the loop provided at the other end making it a noose around coconut palm. The free end is then connected to a commercially available body harness. The wire rope moves up and down along with the climbing machine during operation. In case of any eventuality, failure of the machine or accidental falling of the



Fig. 2.39: Coconut climbing using Chemberi model climbing machine with CPCRI safety attachment



Fig. 2.40: CPCRI safety attachment

climber from the machine, the steel rope noose gets tightened to the coconut trunk and prevents the climber from further falling (Fig.2.40). The safety attachment is independent of the climbing machine and gives fool proof safety to the climber from falling.

The safety attachment can provides fool proof safety to the traditional coconut climbing also (Fig.2.41).

2.6.2.2 TNAU Model

This was developed by Tamil Nadu Agricultural University (TNAU) (Fig.2.42) under Farm Implements and Machinery (FIM) Scheme, which was modified later in Ergonomics and Safety in Agriculture Scheme. This is a sitting type or push up type model. The device has two MS frames; one upper and lower; they are connected by a belt while the equipment is on the coconut tree. The user has to sit on the seat which is provided on upper frame and has to insert his foot between the rubber rollers available in the lower frame. The upper frame can be lifted by hands and the lower frame has to be lifted by leg. The process has to be repeated for the continuous climbing. In this type, the size can be adjusted as per the coconut tree diameter. As both frames are positioned in angle, due to the friction by rubber bush it will get cling to the tree and the process has to repeat for further climbing. Safety belt can be adjusted for proper body posture. Distance between the top and bottom frames can be adjusted by the belt as per the convenience.



Fig. 2.41: CPCRI safety attachment for traditional coconut climbing



Fig. 2.42: TNAU model coconut climbing machine

2.7 POST HARVEST PROCESSING MACHINERIES

Coconut serves as the basic raw material for a series of agro-processing activities and sustains the livelihood of over 10 million people in the country. Copra, coconut oil, desiccated coconut, coconut cream, coconut milk powder, Virgin Coconut Oil, Coconut chips etc. are few among the products using coconut kernel as the raw material. Apart from these products many other products and byproducts are available in the market that uses coconut as the raw material.

Many of the unit operations involved in coconut processing was done manually till recently.

These unit operations involved in the production process were all quite cumbersome and involves a lot of drudgery, especially to women folk. Research and development by private entrepreneurs and institutions in public sector lead to the development of a series of machineries that could reduce the drudgery and made the coconut processing industry more competitive. The non favouring benefit cost ratio due to the high labour involvement was the major reason that prevented entrepreneurs from taking up the coconut processing technology. Machineries/ gadgets required for all the unit operations involved in the production of virgin coconut oil and coconut chips to reduce the human drudgery and thereby enhance the output many fold were developed and commercialised by the ICAR-CPCRI.

2.7.1 Coconut De-husking Machine

Coconut de-husking is the first post harvest operation in any coconut processing industry. Traditionally coconut is dehusked manually using a spike. Drudgery and risk of getting injured make the operation male dominated. ‘Keramitra’, the coconut dehusking machine developed by Kerala Agricultural University is a very popular device in households (Fig.2.43). However, the extremely low output is a major constraint.

A power operated semi automatic coconut de-husking machine has been designed and fabricated at ICAR-CPCRI (Fig.2.44). Dehusking is done by passing coconut over two spiked rollers rotating at different speed in opposite directions. The coconut is pressed towards the rollers with the help of a pneumatic cylinder. Husk is removed by the rotating spikes. However, a small portion of the coir fibre would remain at the eye of the coconut. This would then fall on a pair of rollers rotating at the same speed but in opposite directions. The remaining coir also would be detached and the fully dehusked coconut can be collected at the opposite side. The rollers are rotated by an electric motor. Feeding is done by manually. Though the machine would not replace manual labour, the drudgery involved in de-husking is totally avoided.

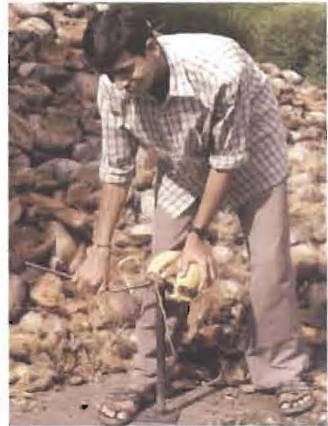


Fig. 2.43: Keramitra



Fig. 2.44: Coconut de-husking machine

Everybody including ladies would be able to use the machine even without training. The machine has a capacity to de-husk 200 coconuts per hour.

2.7.2 Coconut Splitting Device

To solve the problem of splitting of coconuts by holding it in hand, a manually operated splitting device is developed at CPCRI (Fig 2.45). Knife of the machine is made of spring steel and is kept at a bevel angle of 25 degree. As the cutting blade is made of spring steel, it does not require frequent sharpening. Nut is split manually by the impact force and the nut water is collected at the bottom.

2.7.3 Copra Dryers

The common practice of making copra is by sun drying the fresh coconut kernel on cement floor or on sand floor for seven to nine days. Unlike in other crops, the endosperm of coconut is exposed while drying and so is susceptible for contamination due to dirt. Prolonged drying, especially during monsoon, also results in microbial infection. The energy efficient dryers developed by CPCRI produce dust and microbial contamination free copra in a short period.

2.7.3.1 Small Holder Copra Dryer

This is an indirect dryer (Fig.2.46) that can dry up to 400 coconuts per batch, ideal for a farmer to make copra in the farm itself. Any agricultural waste could use as fuel. It takes 36 hours to get quality copra. A person needs to be near the dryer to feed fuel in every half an hour. This is the major disadvantage of the dryer.

2.7.3.2 Shell Fired Copra Dryer

The copra dryer (Fig.2.47) is working on indirect heating and natural convection principles using coconut shell as fuel. This dryer requires less amount of fuel, makes copra in short time and less expensive too.



Fig. 2.45: Coconut Splitting Device



Fig. 2.46: Small holder copra dryer



Fig. 2.47: Shell Fired Copra Dryer

Capacity of the dryer is 1000 nuts per batch. The quality of copra obtained is light brown in color which fetches good price in the market. The burner designed generates heat for 5 hours without tending and the residual heat is retained for one more hour. The average drying time is 24 h.

2.7.3.3 Forced Circulation Copra Dryer

Forced circulation dryers (Fig.2.48) are more efficient and much faster than the dryers using natural convection to dry copra. Several types of such dryers are available in the market with varying capacities to suit the requirement of the copra industry.



Fig. 2.48: Forced circulation copra dryer

2.7.3.4 Solar Tunnel Dryer

A solar tunnel dryer with a capacity of 1500 coconuts/ batch is developed that produces good quality copra in a shorter time (Fig.2.49). It consists of a semi cylindrical shape tunnel structure having a transparent cover made from UV stabilized polyethylene film of 200-micron thickness. The solar collector is the black polyethylene film of 250-



Fig. 2.49: Solar tunnel dryer with electricity as an alternate source of energy

micron thickness spread on the ground inside the dryer for better absorption of solar heat. The temperature inside the dryer is 20-25°C higher than the ambient and the R.H. value is 20-22% lower than the ambient. The copra in this is less infested by fungi and bacteria than that produced by open sun drying. Drying time taken to dry copra is 32 sunshine hours. The dryer can also be used to dry other plantation crops produces.

Solar drying relies on the sun as the source of energy. For cloudy and rainy days, a multi source dryer also has been developed with solar energy as the main source of energy and electricity as alternate sources of energy.

2.7.3.5 Solar Cum Electrical Dryer with Agricultural Waste as Third Source of Energy

Solar drying relies on the sun as the source of energy. It generates higher air temperature and consequential lower relative humidity. For cloudy and rainy

days, a multi source dryer has been developed with solar energy as the main source of energy and electricity and bio-fuel as alternate sources of energy. The dryer (Fig.2.50) consists of a semi circular parallel plate solar collector, electric heaters of 1000 W (6 numbers), blower cum exhaust motor and the drying chamber. It is a auto regulated dryer with temperature and humidity control. It is a batch type dryer and the capacity of the dryer is 2000 coconuts / batch. The dryer can be used to dry other crops such as cardamom.



Fig. 2.50: Solar cum electrical dryer with agricultural waste as third source of energy

2.7.4 Coconut De-shelling Machine

A power operated batch type coconut de-shelling machine (Fig.2.51) has been developed to separate shell and copra after partial drying. Capacity of the machine is 400 half cups per batch. The optimum average moisture content for maximum de-shelling efficiency (92.16 %) is 35 % d.b. The optimum speed of the de-shelling machine is 10 RPM and the time taken for de-shelling is 4 minutes per batch.



Fig. 2.51: Coconut de-shelling

2.7.5 Copra Moisture Meter

The quality of milling copra ultimately determines the quality of the oil and the residual cake. Good quality copra will yield oil without refining with free fatty acid content (FFA) of less than one percent. Moisture is the most important factor influencing the quality of copra. Copra with a moisture content of less than six percent is considered good quality as it is not easily damaged by insects, moulds or microorganisms. At the CPCRI, Kasaragod, an electronic moisture meter was developed (Fig.2.52) to determine the moisture content of copra, based on the electrical conductivity of the kernel. The instrument can read moisture content from 5 to 40 percent. It is very handy and the accuracy is more than 94 percent in the lower levels of moisture content readings.



Fig. 2.52: Copra moisture meter

2.7.6 Tender Coconut Punch and Cutter

Tender nut punch and cutter (Fig.2.53) are two simple devices to pierce the tender coconut and cut open it after drinking the water inside. A clean hole sufficient enough to insert a straw is formed and one can drink the fresh water. After drinking the water, the nut is placed on the wooden platform and cut open by pressing the lever attached to the blade. The efficiency is 20 tender coconuts per hour.



Fig. 2.53: Tender coconut punch and cutter

2.7.7 Snow Ball Tender Nut (SBTN) Machine

Snow ball tender coconut is globular tender coconut kernel containing tender coconut water inside. The ball scooped out with the help of specially devised tool after cutting the shell of tender coconut of 7-8 months maturity by using snow ball tender coconut machine (Fig.2.54). The SBTN thereafter is made free of the adhering testa, packed hygienically to use either fresh or after refrigerated storage. Output capacity is 250 coconuts in 8 hours by a person.



Fig. 2.54: Snowball tendernut machine

2.7.8 Coconut Shell Removing Machine

Coconut shell removing is the second post harvest operation in a coconut processing industry using fresh coconut kernel as the raw material. Traditionally coconut shell is removed using a knife (Fig.2.55). Though women do the work, the labour intensive process is not at all attractive to the processing industries.



Fig. 2.55: Coconut shell removing-Conventional



Fig. 2.56: Coconut shell removing machine

Coconut shell removing machine (Fig. 2.56) is intended to reduce both time and drudgery involved in the manual shell removing process. Two concentrically rotating multi pointed circular blades and a stationary pointed blade on which coconut would be placed firmly are the major components of the shell removing machine. Coconut to be processed is pressed towards the rotating blades by firmly placing it on the stationary blade. Shell gets detached from the kernel due to the impact force of the rotating blade. The machine has a capacity to remove the shell of 150 coconuts per hour.

2.7.9 Coconut Testa Removing Machine

Many high value coconut products like, coconut chips, virgin coconut oil, desiccated coconut etc. requires removal of testa. At present, testa is removed manually using potato peeler which is a cumbersome and time consuming process (Fig. 2.57). Moreover, a sizable amount of coconut meat also would be lost along with the removed testa. The coconut testa removing machine (Fig. 2.58) would reduce the drudgery and improve the efficiency and capacity of any production units that requires removal of testa. The main component of the machine is a circular wheel covered with emery cloth or water paper attached to a prime mover, an electric motor. One person can remove testa of about 75 coconuts per hour.



Fig. 2.57: Testa removal-conventional



Fig. 2.58: Testa removing machine

2.7.10 Coconut Slicing Machines

Slicing coconut kernel to produce chips of uniform thickness is the single most important unit operation in the coconut chips making process. Conventionally, this is done manually (Fig. 2.59) and the process is very cumbersome and time consuming. Quality of chips, especially uniformity of thickness, would depend on the skill of the operator.



Fig. 2.59: Manual slicing

In order to make this operation simple and faster two manually operated coconut slicing machines were developed at CPCRI.

2.7.10.1 Electrically Operated Coconut Slicing Machine

Chips making machine (Fig.2.60) has been developed at CPCRI to slice coconut kernel to make chips. The machine can produce coconut slices of required uniform thickness much faster. The machine consists of two stainless steel slicing blades fixed on a circular blade supporting disc, a feeder to insert coconut endosperm for slicing, an exit guide and an electric motor as a prime mover. The electric motor rotates the blade supporting disc using a V-belt. When coconut endosperm comes in to contact with the blades it gets sliced. The sliced coconuts are then guided towards the outlet by the exit guide and are collected

in a container. Coconut slices of uniform and required thickness could be produced using this machine. Provision is made in the slicer to slice tuber crops, banana and vegetables.

2.7.10.2 Manually Operated Coconut Slicing Machine

A manually operated coconut slicing machine (Fig.2.61) has also been developed to produce coconut slices. The machine is quite user friendly especially for ladies who knows operation of sewing machine and does not require electricity. Approximately 25 coconuts can be sliced in one hour using this machine.

2.7.11 Coconut Chips Dryers

Two types of dryers were developed by CPCRI to dry the sliced coconut kernel to the desired moisture content. The electrical dryer (Fig. 2.62) developed consists of a set of 10 trays with wire mesh screens for loading coconut slices. Temperature in the dryer is controlled automatically by a sensor and electronic control unit. Though the dryer is designed for 50 coconuts, the size could be enhanced to any desired capacity.

Another prototype of chips dryers that uses agricultural waste as fuel (Fig.2.63) has been developed. Furnace of this indirect dryer is conveniently placed outdoor and the drying unit indoor. Temperature is controlled by a butterfly valve



Fig. 2.60: Coconutchips making machine



Fig. 2.61: Manuallyoperated coconut slicing machine



Fig. 2.62: Coconut chips dryer-electrical



Drying unit-indoor



Fumace-outdoor

Fig. 2.63: Agricultural waste fired coconut chips dryer

in the hot air inlet. Cost of drying would be less than that of electrical dryer.

2.7.12 Coconut Grating Machines

Two coconut grating machines were developed to enhance the grating efficiency. First one is of single user (Fig.2.64) and the second one is of multi user (four grating blades) type (Fig.2.65). The motorized coconut grating machines developed scrapes off the deshelled coconut flesh into fine gratings with the help of stainless steel blade. The single user machine has a capacity of 60 nuts/h and the multi user has four times a capacity of the first one.



Fig.2.64: Coconut grating machine-single user



Fig. 2.65: Coconut grating machine-multi user

2.7.13 Coconut Pulveriser

The coconut pulveriser (Fig. 2.66) consists of power operated rotary blade. The coconut kernel pieces are fed into the hopper manually. Due to the impact of the rotary blade and the rubbing on the stationary blade, the coconut kernel turns into fine powder. The machine has a capacity of 250 nuts per hour.

2.7.14 Coconut Milk Extractors

Four different coconut milk extractors are developed to enhance the milk extraction efficiency. Two are manually operated and two are hydro pneumatic coconut milk extractors.



Fig. 2.66: Coconut pulveriser

2.7.14.1 Manually Operated Milk Extractor

Both the manual milk extractors (Fig.2.67) are similar to a hand operated vertical screw press. The grated coconuts are kept in a perforated cylinder and by rotating the handle provided at the top of the screw, the gratings are pressed. In the first machine, the whole pressing process is done manually by rotating the handle. In the second machine, an additional hydraulic jack is provided at the bottom. Gratings kept in the perforated cylinder are pressed initially by rotating the handle. Final pressing is done by operating lever of the hydraulic jack. The platform on which the perforated cylinder is kept moves up and exerts pressure on the coconut gratings thereby expelling coconut milk without any effort.



Fig. 2.67: Manually operated coconut milk extractors

2.7.14.2 Hydro Pneumatic Coconut Milk Expellers

Two hydro pneumatic coconut milk extractors (Fig.2.68) of different capacities were also developed for large scale extraction of coconut milk. The operation of both the machines is completely automated using a programmable logical controller. The user can programme the operation of these machines, i.e. extraction pressure, frequency and duration of pressing etc. using the programmable logical controller as per the requirement. They are useful for large scale extraction of coconut milk in coconut milk



Fig. 2.68: Hydro pneumatic coconut milk expellers

processing industries and virgin coconut oil production centres. The smaller machine is having a capacity of handling 250nuts per hour where as the bigger machine can handle 500nuts per hour.

2.7.14.3 Screw Type Coconut Milk Expellers

Two screw type coconut milk expellers, single (Fig. 2.69) and double (Fig. 2.70) screw, with different capacities have been developed to extract coconut milk. The screw type expellers have the maximum extraction efficiency among different types of coconut milk extractors. The single screw expeller has a capacity of 300coconuts per hour and the double screw has a capacity of 1000coconuts per hour. The third expeller is a single screw type with an inbuilt cooling mechanism (Fig. 2.71) to extract coconut milk at room temperature. It has a capacity of 300coconuts per hour.



Fig. 2.69: Single Screw Coconut Milk Expeller

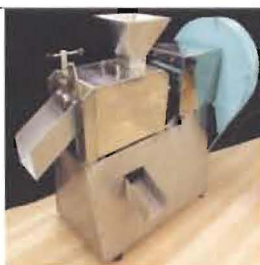


Fig. 2.70: Double Screw Coconut Milk Expeller



Fig. 2.71: Single Screw Type Coconut Milk Expeller with cooling mechanism

2.7.17 Virgin Coconut Oil Cookers

CPCRI has standardized the protocol and commercialized the technique to producing virgin coconut oil by hot processing method. Conventionally virgin coconut oil is prepared by heating coconut milk in an open container at low flame with continuous stirring. It is done manually and the constant stirring is a laborious process. Many a times, the milk gets charred and the charred milk stick to the bottom and the sides of the vessel. This happens when the stirring is not proper or when excess fuel is burnt. In order to overcome the limitations of the traditional virgin coconut oil (VCO) production, two types of VCO cookers were developed at CPCRI to extract the VCO by hot processing. One machine uses LPG/ biogas as fuel and the other one uses any agricultural waste as fuel source.

2.7.17.1 Virgin Coconut Oil Cooker-LPG/ Biogas

This virgin coconut oil cooker (Fig. 2.72) developed by the institute consists of a double jacketed vessel filled with thermic fluid. The thermic fluid ensures efficient and uniform heat transfer to coconut milk kept in the cooker. Four teflon tipped stirrers are provided to stir coconut milk. This helps the cooker to distribute heat energy uniformly within the coconut milk kept in the cooker. The

stirrers are powered by an electric motor with a reduction gear. An outlet with a door attached to a lever is provided at the bottom of the cooker to take out the extracted oil. The cooker is supported by three legs with sufficient clearance from ground for easy collection of extracted oil. A thermometer is provided to measure the temperature of the thermic fluid so that it can be kept from 100-120 °C. A safety valve also is provided for extra safety by releasing the pressure developed, if any, in the thermic fluid chamber. The cooker is heated by two burners provided at the bottom of the heating chamber. Biogas or LPG could be used as fuel. Virgin coconut oil Cooker has a capacity of 125 litres. However, a VCO cooker of any capacity can be fabricated by scaling up the design.



Fig. 2.72: Virgin coconut oil cooker-LPG/ Biogas

2.7.17.2 Agricultural Waste Fired Virgin Coconut Oil Cooker

Agricultural waste fired virgin coconut oil cooker (Fig.2.73)also is used to extract virgin coconut oil from coconut milk. It consists of a double jacketed vessel filled with thermic fluid. The thermic fluid ensures efficient and uniform heat transfer to coconut milk kept in the cooker. Four Teflon tipped stirrers are provided to stir coconut milk. This helps the cooker to distribute heat energy uniformly within the coconut milk kept in the cooker. The stirrers are powered by an electric motor with a reduction gear. An outlet with a door attached to a lever is provided at the bottom of the cooker to take out the extracted oil. The cooker is supported by three legs with sufficient clearance from ground for easy collection of extracted oil. A thermometer is provided to measure the temperature of the thermic fluid so that it can be kept from 100-120 °C. A safety valve also is provided for extra safety by releasing the pressure developed, if any, in the thermic fluid chamber. A burning chamber is provided at the bottom of the double jacketed vessel. The cooker is heated by burning any agricultural waste, preferably coconut shell, in the burning chamber. An opening is provided at the front to feed the fuel. An exhaust to remove smoke is provided at the



Fig. 2.73: Agricultural Waste Fired Virgin Coconut Oil Cooker

opposite side and is connected to a chimney kept outdoor for easy combustion of fuel. Virgin coconut oil cooker of this type can be fabricated as per the capacity required by the user.

2.8. FUTURE PERSPECTIVE

‘Zero tillage’ where only very minimum disturbance is needed, is the buzz word now among research fraternity and several farmers. Coconut requires minimum operation like basin opening where fertilizer and water is applied for efficient uptake and utilization. A self propelled or more suitable power tiller attached coconut basin opener would be of much relief to farmers who opt for conventional mode of cultivation. Another greatest challenge faced by coconut farmers is the climbing coconut tree for collecting the tender nut, mature nuts and for other plant protection operations. Though the Joseph model of coconut climbing machine is gaining popularity, thanks to the initiative of Coconut Development Board (CDB), yet climbing the tree for harvesting would be prohibitively costly considering the stagnant price and productivity of coconut palm. Therefore, developing a mechanized device to harvest coconut from ground is the need of the hour. Invariably this should be focal point of researchers. Coconut de shelling and de husking are the other two operations that require further mechanization. Though few prototypes of coconut de shelling and de husking machineries are either available or are in the pipe line, manual labour could not be avoided totally in these operations. Mechanization in coconut processing is much more advanced than mechanization in farm operations and harvesting. However, there is a need for developing appropriate processing techniques and machinery suitable for community level processing of value added products like VCO, coconut chips, desiccated coconut, coconut milk, coconut milk powder etc. Though it may not be possible in the near future, a completely automated processing plant should be the ultimate aim of coconut research organizations.

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