GEO
Guyana Economic Opportunities

Coconut Husk Extraction and Coir Processing: Potential Value-Added Export Products

Prepared by:
David H. Picha

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Chemonics International Inc.

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Introduction

Coconut is one of the most useful and important plants in Guyana. The inner portion of the fruit provides a diversity of nutritious products, including a natural coconut water beverage, edible raw pulp, and dried copra (dried endosperm), which is the source of coconut oil. The outer portion of the fruit (husk) can be dried and the fiber and pith extracted for use in the manufacture of a number of products. Coir is the term used to describe the coarse brown fiber of the coconut husk (Figure 1). Coir fiber is light weight, strong, elastic, and has a high durability. Coir fiber is relatively water-proof and is the only natural fiber resistant to damage by salt water and microbial degradation. The long fibers of the husk can be used to make floor mats, ropes, brooms, nets, and carpets. Coir pith, the short fibers and dust left behind after the industrially valuable long fibers of coir are extracted from the coconut husk, is widely used throughout the world as a constituent in horticultural-grade growing media for vegetables, ornamental plants, roses, cut flowers, and nursery crops. Most coir pith is obtained from the husks of mature coconuts as a by-product of copra production.

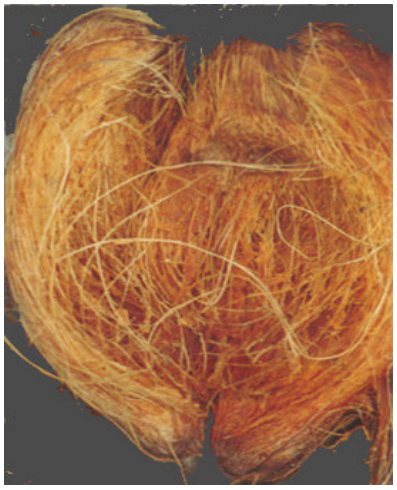

Figure 1. The outer husk of the coconut fruit is the source of fiber and coir pith.

The purpose of this bulletin is to provide information on coir extraction, processing techniques and equipment, and marketable products. It is intended to support the development of additional value-added coconut export products from Guyana.

Processing Methodology

De-husking

The fibrous outer husk of the coconut can be separated from the hard inner shell by various manual or mechanical methods. The most labor intensive manual method involves splitting the fruit open with a machete, followed by hand removal of the husk. A slightly improved manual method involves driving the fruit down onto a hard metal spike or stake (Figure 2). This splits the fruit and allows for manual removal of the husk. The fiber is separated from the nut using a twisting motion. With this technique, the best human laborers can de-husk around 400 coconuts per day.

Figure 2. Removal of coconut husk by manually driving the fruit on a metal spike (left) followed by hand removal of the husk (right).

A simple hand operated portable de-husking device is also commercially available (Figure 3). It is a light weight (approximately 2.5 kg), pedestal mounted unit, with a twin blade opening mechanism. The coconut is impaled on the upright wedge-like twin blades by hand and a sector of the husk pried open by separating the movable blade from the stationary blade by lifting the hand lever. This operation is typically repeated several times to remove the remaining husk. This device is used in India, with significantly improved de-husking efficiency and output. Information on price and availability can be obtained by contacting the following institute:

Directory of Rural Technologies
National Institute of Rural Development
Rajendranagar, Hyderabad 500030
Andhra Pradesh, India
phone: 91-40-24008522
fax: 91-40-24015277

Figure 3. Portable coconut de-husking device popular in India.

Higher capacity and more durable units are also available, many capable of being made on the farm. A schematic diagram of the essential components of one such machine is illustrated in Figure 4.

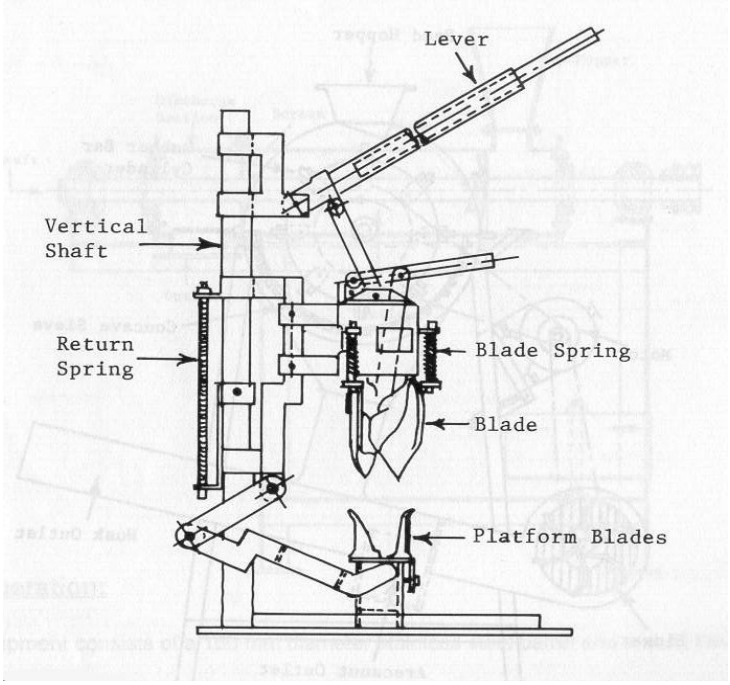

Figure 4. Schematic diagram of coconut de-husker.

The husk can also be removed with a high capacity mechanical cutting device. A robust hydraulically-operated coconut de-husking machine is commercially available from an Australian company:

Fletchers Engineering Ltd
PO Box 5017
Murwillumbah NSW
Australia 2484
phone: 61-266 721 055
fax: 61-266 724 347

It is easy to operate and repair and is capable of de-husking a coconut within 10 seconds. It is a safe and reliable machine that uses high tensile steel cutting blades to make the de-husking process quick and efficient (Figure 5). The de-husker may be powered by a mounted electric motor, a gasoline or diesel-fueled engine, or even by a tractor's hydraulic system. If continuously operated, the machine can de-husk over 2500 coconuts in an 8-hour day. The only required maintenance involves a daily check of the nuts and bolts and oiling twice a day. This process takes about 10 minutes. Blade sharpening is not necessary, and they should last for years. The husk removal process using this machine is illustrated in Figures 6 through 9.

Figure 5. Coconut de-husking machine.

Figure 6. Coconut resting on the base knives with the fruit attachment scar pointing to the center of the husking arms.

Figure 7. The husking arm assembly is lowered until good penetration into husk is attained.

Figure 8. The husking arm assembly splits open the husk (left) and removes it from the coconut (right).

Figure 9. De-husked coconut being taken off the machine.

Retting

After manual separation of the nut from the husk, the husks are processed by various retting techniques. The coconut husk fibers are ordinarily freed from other husk tissues by retting, a process utilizing the action of microorganisms in a suitably moist environment to rot the weaker husk tissue surrounding the tougher fibers. The retting process typically involves burying the coconut husks in wet soil, allowing microbial degradation of the softer tissues (Figure 10). Coconut husks can also be retted by soaking in a stream or river for 3 to 6 months until the fiber becomes loose and soft. The outer husks are tied in nets or formed into rafts and then weighted down to sink in the water (Figure 11). The time required for retting is influenced by various factors, especially the maturity stage of the coconuts and the temperature. Coir is typically processed from ripe coconut husks which are dark brown in color and have been retted in freshwater. The retting process of coconut husks acts as a curing process for the fiber in the husk. Retting in freshwater increases resistance to ultraviolet light degradation and also increases the flexibility of the processed fiber, without causing deterioration. Experience has shown that only the traditional brown bristle coir which is processed from ripe brown coconut husks cured for at least six months in freshwater has

performed well in applications where durability and strength retention are critical for satisfactory field performances.

Figure 10. Women uncovering retted coconuts; additional fruits are buried in the mound to the rear to begin the retting process.

Figure 11. Rafts of coconut husks being retted by soaking in river.

Unripe green coconut husks are usually soaked in salt water to make the coir processing easier. The salt in lagoon or river water near the ocean makes it easier to process unripe green coconut husks. Coir processed from lagoon-retted green husks is light brown or white in color. Lagoon-retted brown coconut husks also produce white coir. The salt in the lagoon water acts as a bleaching agent, however, it weakens the coir fiber. White coir obtained from green husks is typically much weaker than brown bristle coir obtained from ripe brown husks. Also, resistance to ultra-violet light degradation in brown coir obtained from ripe husks is much higher than white coir obtained from unripe green husks.

De-fibering

After retting, the fibers in the husk are softened and can be separated (decorticated) and extracted. The de-fibering process can be done manually by hand beating, or mechanically with de-fibering machines. In the manual process, the decayed skin is peeled off and the

rotted husk is beaten on a stone with a heavy wooden bar. The fiber may also be extracted by pounding with mallets against slabs of wood (Figure 12). The fiber is then spread out to dry in the sun and beaten again with long sticks to remove husk particles.

Figure 12. Manual pounding of coconut husks with wooden mallets against stone or slabs of wood to extract the fiber.

High demand for coir has led to the development of mechanical coir processing methods. Mechanical de-fibering equipment can be used to separate fiber from non-retted or partially retted husks green or ripe brown husks (Figure 13). Advantages of these de-fibering machines to the coir producer include reduced expense and faster production rates, and the six-month retting time is reduced or eliminated. These machines yield a mixture of long and short (strong and weak) fibers. The length of the coconut fibers typically range from 10-30 cm. Generally, about one-third fiber and two-thirds pith is obtained in the process of extraction of coir from the husk. An average coconut husk weighs about 300 g, from which is obtained around 100 gm of fiber and about 200 gm of coir pith. Therefore, about 5000 husks must be de-fibered to produce about 500 kg (0.5 ton) of fiber and 1000 kg (1 ton) of coir pith.

Figure 13. A 15-horsepower (left) and 7.5 horsepower (right) de-fibering machine (1000 husks per hour capacity) for mechanical extraction of coconut husk fiber.

By using revolving drums or rotating chains, the coarse long fibers are separated from the short woody parts and the pith (Figure 14).

Figure 14. Mechanical separation of coconut husk fibers using a series of rotating chains.

Several kinds of coconut fibers can be obtained based on the raw material or type of extraction method. The best fibers come from immature coconuts (Figure 15). White fiber is considered to be superior in color and quality, and is obtained by manual hand beating of the retted green husks (Figure 16). Retted fibers from green husks are light colored and pliable, which are the most suitable for dyeing and bleaching.

Figure 15. Immature coconut husks are the source of the highest quality fiber.

Figure 16. High quality white fiber is obtained from retted green coconut husks.

Brown fiber is poorer in quality and is either obtained by manual hand beating or mechanical extraction of mature husks (Figure 17). Brown fiber is obtained from the husks of fully mature coconuts harvested for copra.

Figure 17. Brown fiber obtained from mature coconut husks.

The separated coir fibers are easily fluffed and dried in the sun or in the shade. The longer fiber is generally washed in clean water before drying. After drying, the coir fiber is gathered and tied into large loose bundles (Figure 18). The bundles should be covered or moved under sheltered overhangs so they will not get wet if it rains. The fibers may also be run through steel combs for straightening and removal of the shorter pieces. In some cases, the fiber is spun by hand or on spinning wheels and twisted into yarn to supply raw material for weavers.

Figure 18. The dried coir fibers are tied into large loose bundles (left) and transported along a canal by canoe (right).

Fiber Grading

The fiber extraction process yields different and varying qualities of fibers. Generally, mature coconut husks provide 56-65 per cent long fibers (over 15 cm) and 5-8 per cent short fibers (under 5 cm). The fiber thickness varies between 50 and 300 µm. Coconut husk fiber is typically graded by skilled labor based on the length of the fiber, color, and the amount of

impurities. Various types of fibers are shown in Figure 19. The shorter and thinner fibers are called mattress coir and the longer and stronger fibers are called bristle coir.

Figure 19. Various types of coir fiber include: mattress fiber (left), bristle fiber (center), and un-retted fiber (right).

Bleaching

Bleaching of coir fibers and yarn is done to obtain lighter colored fibers and more commercially attractive products. On the other hand, the brown-colored coir from ripe husks is more attractive than white color for erosion control applications. Several hues and shades of dyed coir can be obtained when the coir is bleached. Hydrogen peroxide is the most commonly used bleaching agent. It is inexpensive and can be used safely. However, hydrogen peroxide is an irritant for the eyes and respiratory system, and it is important to use appropriate safety procedures to protect the workers. It is important to maintain the optimum degree of hydrogen peroxide stability, so the full potential of the bleaching activity can be realized. The efficiency of peroxide bleaching is affected by pH and the presence of contaminants in the processing water (e.g. ionic metal complexes). The addition of magnesium sulfate and sodium silicate to the medium is required to stabilize the peroxide in alkaline conditions. Surfactants are also used to increase the fiber surface reactivity. Chemical bleaching may have some negative effects on the strength and durability of coir. Also, addition of chemicals to natural coir may create a potentially hazardous environmental situation. The chemicals used for bleaching should always be properly contained and disposed of in accordance with environmentally acceptable procedures.

Coir Products

A variety of potential export products can be made from coir fiber and coir pith. These include mats, yarn, netting, geo-textiles, and horticultural-grade growing media for plants.

Various types of matting products can be made from coir fiber (Figure 20). The most common ones are floor mats, rugs, and carpets.

Figure 20. Weaved floor mat (left), rug (center), and non-woven carpets (right).

Yarn and twine are potential export products made from coir fiber. Yarn and twine is generally 2-ply in thickness and can be made in different forms and lengths for various industrial and agricultural purposes (Figure 21, 22). Freshwater-retted brown bristle coir twines are the most durable and retain the highest strength in field applications compared to twines made of any other coir.

Figure 21. Machine (left) for spinning coir fibers into bobbins of yarn (right).

Figure 22. Use of coir twine to train hop vines. Coir twine is also commonly used to tie staked field tomatoes.

Nets are also popular products made from coir fiber (Figure 23). They can be fabricated into different mesh sizes, lengths, and tensile strengths.

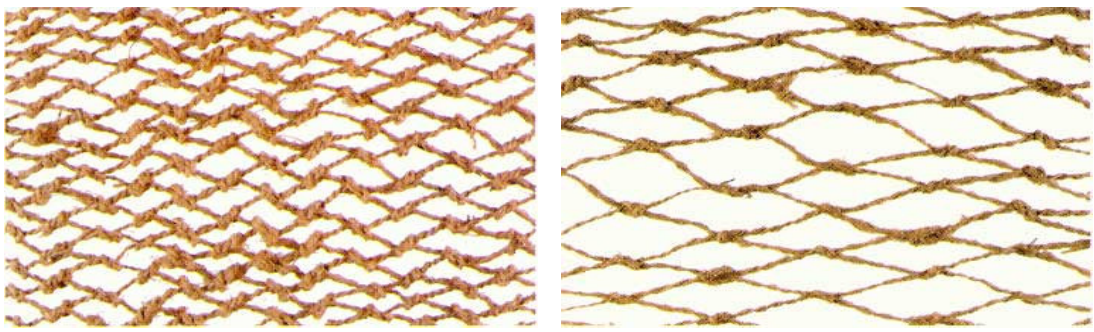

Figure 23. Coconut fiber net knotted by hand in different mesh sizes.

There has been a rapid growth in the use of natural soil erosion and sedimentation control geo-textiles, especially in environmentally sensitive areas (Figure 24). Most of these geo-textiles incorporate coir products (Figure 25) to provide the required initial structural stability until the establishment of sustainable vegetation. Coir is a natural, eco-friendly product that is slowly but totally biodegradable. Coir is an abundant, renewable natural resource with an extremely low decomposition rate and a high strength compared to other natural fibers. In traditional erosion control blanket applications, coir geo-textile blankets are well known for superior performance compared to other organic blankets.

Figure 24. Coir blankets used for river bank stabilization.

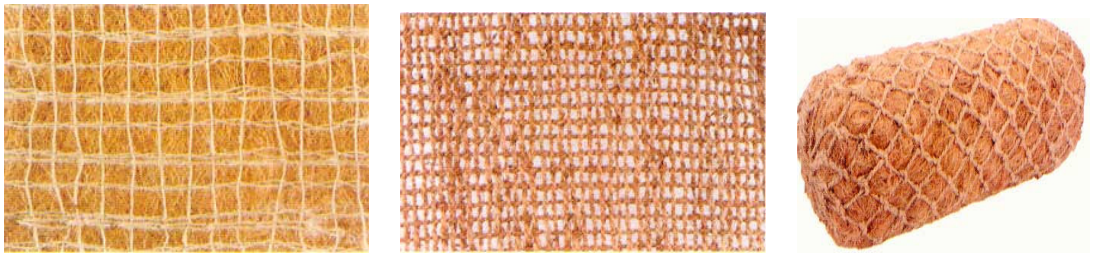

Figure 25. Different types of coir geo-textiles include erosion-control blankets (left), mesh matting for greenhouses and nurseries (center), and thickly filled fiber logs in cylindrical shaped coir netting (right).

Coir pith is a spongy material that binds the coconut fiber in the husk. It is the leftover dust after extracting the coir fibers from coconut husks (Figure 26). It is an excellent soil conditioner and is being extensively used as a soil-less medium for horticultural purposes. With its moisture retention qualities, coir pith is ideal for growing flowering plants, ornamentals, and a variety of vegetables. Coir pith is sometimes marketed under the generic name of coco peat (Figure 27). The coir pith is washed, heat treated, screened, and graded before being processed into various coco peat products (Figure 28).

Figure 26. Pile of coir pith (dust) remaining after extraction of coconut husk fibers.

Figure 27. Bagged coir pith (left) for sale as a plant potting media (right).

Figure 28. Coir pith products used as growing media for horticultural purposes include blocks (left), pots (center), and soil-less mixes (right).

Coir pith has a high lignin (~31%) and cellulose (~27 %) content. The pith is very stable because of the presence of a high percentage of lignin. Hence, coir pith may take decades to decompose. Coir is typically equal to or superior to various types of peat as a potting media component for most crops. The physical characteristics of coir pith appear more stable over time than either sedge peat or sphagnum peat. Coir is better aerated and holds more water, and does not break down or compact. Coir pith has a very high water holding capacity, typically around 6-8 times its weight. Incorporation of 2 percent weight of coir pith with sand will increase the water holding capacity of the sand by 40 percent. The pH of coir typically ranges from 5.5 to 6.5, which is acceptable for the growth of most crops. Coir pith also contains valuable amounts of nutrients (4.4 kg N/ton, 0.7 kg P_2O_5/ton, and 1 kg K_2O/ton).

Alternatives to peat must be developed in order to meet environmental concerns of consumers and to contend with increased regulation of peat land exploitation. Peat extraction has been banned in most European countries. Environmentally, coir is a renewable by-product. If high quality coir pith from Guyana can be exported to the U. S. at a price competitive with sphagnum peat, it should find a ready market.

Compost

Coir pith compost developed from coir waste is a good organic manure and soil conditioner for agricultural crops. In addition to its export potential, this material is of value as a domestic soil amendment. Coir pith compost improves the physical and chemical properties of the soil and enhances the yield of a wide range of crops. The protocol for converting coir pith into compost is simple (Figure 29). A spawn of edible mushroom (*Pleurotus sajor caju*) added to the coir pith speeds up the decomposition process and reduces the coir pith volume by over 40%. The following protocol can be used to prepare coir pith compost:

-select a sheltered place, preferably under a tree or coconut palm thatching, to protect the coir pith pile from direct sun and heavy rain
-spread uniformly 100 kg of coir pith in an area of 5 m X 3 m
-apply spawn of *Pleurotus sajor caju* uniformly over the coir pith pile
-cover with 100 kg coir pith and apply 1 kg urea uniformly over pile
-cover with an additional 100 kg of coir pith
-repeat the sandwiching process until the pile reaches 1 meter in height
-moisten the pile daily by sprinkling sufficient water, but do not flood it
-allow the pile to decompose for 30 days.

Figure 29. Various steps in the conversion of coir pith into compost.

A comparison of the nutrient content of raw coir pith versus composted pith is shown below. In addition, the recommended application dosage of coir compost is indicated for various crops.

Nutrient Content	Raw Coir Pith	Composted Pith
Nitrogen	0.26%	1.26%
Phosphorous	0.01%	0.06%
Potassium	0.78%	1.20%
Calcium	0.40%	0.50%
Magnesium	0.36%	0.48%
Iron (ppm)	0.07	0.09
Manganese (ppm)	12.50	25.0
Zinc (ppm)	7.50	15.80
Copper (ppm)	3.10	6.20
Lignin	30%	4.20%
Cellulose	26%	10.10%
C:N ratio	112:1	24:1
pH	5.5-6.1	6.2-6.9
EC (mhos/ cm)	0.4-1	< 0.25

Recommended Application Dosage of Coir Compost

Coconut	12 kg/ tree
Oil palm	5-10 kg/ ha
Cashew	5 kg/ tree
Banana	3 kg/ plant
Rice	2 tons/ ha
Maize	5 tons/ ha
Calaloo	5 tons/ ha
Cassava	8 tons/ ha
Tomato	5 tons/ ha
Cucumber	10 tons/ ha
Bitter melon	10 tons/ ha
Eddoe	2 tons/ ha
Ornamental plants	0.5-2.0 kg/ plant

Market Opportunities

Guyanese coconut farmers have the potential to earn additional income through the sale of coir fiber and coir pith products. The leading export markets for coir and coir products are the U.S., Germany, U.K., France, and Italy. Currently, the global market for coir is dominated by suppliers from India and Sri Lanka, with lesser quantities coming from the Philippines and Indonesia. Statistics from the Central Institute of Coir Technology in India indicate the world

export value of coir products has totaled around $5 billion annually over the past 5 years. The world demand for coir pith (coco peat) used as an ingredient in horticultural growing media is increasing. Present demand for coco peat in the Netherlands is estimated at 60,000 metric tons per year. Estimated market demand in other countries, including the U.S., France, Canada, Japan, and Singapore combined are of the order of an additional 100,000 metric tons. World market demand for coir pith is estimated to be growing at over 15% per year.

Importers of Coir and Coir Products

The following businesses are potential importers of coir fiber or coir pith from Guyana. They should be contacted on an individual basis to determine their potential needs and coir quality specifications.

Sai International Trading Corp.
1111 Rancho Conejo Blvd.
Suite #506
Newbury Park, California 91320
phone: 805-375-3711
fax: 805-375-1433

Sai International is a California-based manufacturer and importer of specialized growing media and landscape products.

The Scotts Company
14111 Scottslawn Road
Marysville, Ohio 43041
phone: 937-644-0011

The Scotts Company is one of the world's leading suppliers of horticultural products for homeowners and commercial growing operations. They are importers and vendors of coir-based products used as growing media.

PacifiCoir Inc.
1310 S. Swaner Road
Salt Lake City, UT 84104.
phone: 888-443-8989
fax: 801-972-5089

PacifiCoir Inc. is a wholesale nursery supply company that markets a diversity of coir products.

Millenniumsoils Coir
111 Fourth Avenue, Suite 371
St. Catharines, Ontario
Canada L2S 3P5
phone: 905-687-1877
fax: 905-687-8635

Millenniumsoils Coir is an importer and manufacturer of coir growing media for distribution throughout North America. Raw product is currently sourced from Sri Lanka.

Caribbean Gardens
6000 Arbour Lane
Minneapolis, Minnesota 55436
phone: 952-250-8253
fax: 952-925-2995

Caribbean Gardens is a wholesale and retail supplier of coconut coir and garden related products throughout the U.S.

CCC International
903-A Kincannon Place
Lorton, Virginia 22079
phone: 703-550-0222
fax: 703-550-0297

CCC International imports coir fiber for further processing into rugs, carpets, and other consumer products.

Haroonian Rug Company
P.O. Box 10876,
Beverly Hills, California 90213
phone: 310-838-0450
fax: 310-838-3868

Haroonian Rug Company imports coir fiber for further processing into rugs and carpets.

Obeetee Inc.
295 Madison Avenue
Suite 904
New York, NY 10017
phone: 631-422-6017

Obeetee Inc. is an importer of coir rugs, mostly from sources in India.

Horticultural Coir Limited
14 Rumbold Road
London, SW6 2JA
England
phone: 44-207-731-2013
fax: 44-207-731-8482

Horticultural Coir Ltd. markets composted coir as a plant growing media throughout the UK.