

inherently know these benefits, which are part of their indigenous knowledge. However, only a few farmers have the capacity to practice intercropping and of those who practice intercropping, it is simply for subsistence and not for profit. Although most coconut farmers are aware that their farms can be more productive through intercropping, they have no access to appropriate technology, quality seeds, capital and market to make coconut-based intercropping a profitable enterprise.

The potential benefits of intercropping among resource-poor people can be maximized if access to the above-mentioned resources can be provided. Thus, these productivity constraints were addressed through the COGENT's ADB-funded poverty reduction project. Through the project, needy farmers and interested unemployed and underemployed rural women were trained on coconut-based intercropping to provide them the needed technologies to achieve optimum farm productivity. They were then provided loans from the project's revolving fund (for microcredit) through their community-based organizations (CBOs) to support their intercropping trials. Initially, most planting materials were sourced from government stations, private seed companies and from other farmers. Subsequently, some CBOs were encouraged to establish community-managed nurseries where quality planting materials were propagated and loaned out to the farmer cooperators. These planting materials and other recommended farm inputs (e.g. fertilizers and chemicals) were issued as non-collateralized loans (in kind or in cash) and repaid at low interest rates, based on the agreed terms between the lending CBO and the borrower. The CBO leaders and extension officers, with the help of researchers also conducted market surveys to identify suitable markets for the cooperators' produce. The family members, especially the wives of farmers, sell their farm produce directly to the consumers, when possible, to avoid the middlemen and secure a better profit from their sales. The CBOs also helped in collective marketing of their products for distant market outlets.

In a period of two years, 3 999 farmers and underemployed and unemployed women in 24 community project sites participated in intercropping trials consisting of 115 in Bangladesh, 454 in Fiji, 759 in India, 748 in Indonesia, 418 in Papua New Guinea, 473 in the Philippines, 328 in Sri Lanka, and 704 in Vietnam. Net incomes from planting cash crops in small plots (0.1-0.2 ha) of land between coconuts in 1-3 months ranged from US\$ 47- US\$ 86 from vegetables in Bangladesh; US\$157-\$335 from vegetables and root crops in 0.4 ha in India; US\$35/month from vegetables and banana in 0.4 ha in Sri Lanka; and US\$ 50/ month from peanut-corn-banana in 2 ha in Indonesia. It is expected that the farm income in Sri Lanka and Indonesia will increase further once the banana intercrops are harvested. The aggregate annual income of US\$1 500 from vegetables and root crops in 2 ha in Papua New Guinea; and US\$417 in 0.8 ha lemon intercrop in Vietnam were likewise obtained.

The increased income and total farm productivity was only part of the benefit. An equally important benefit was the enhanced food security and nutrition from growing and consuming root crops, vegetables, and other food crops. One housewife participant in the trial related that as a result of the intercropping activities, her family is now assured of 'longer meals' which was due to more food on the table derived from the intercrops which she herself produces.

Animal production

Raising poultry and livestock in a coconut-based farming system has definite advantages for enhancing incomes and improving the nutrition of the members of resource-poor farm families. In many coconut growing communities, family diets are usually high in carbohydrates but deficient in protein, minerals and vitamins which have caused malnutrition. As a coconut farm uses only about 50% of the solar energy for the coconut, a lot of the excess energy can also be used to grow grains, grass and legumes for animal feed. Maize can be grown and home-made feed can be formulated with maize as the main

ingredient mixed with locally sourced ingredients such as copra meal, rice bran, sweet potato leaves and roots, cassava, mungbean, soybean meal, ipil-ipil leaves, etc. For the ruminants, grass and pasture legumes can be harvested and fed on a cut-and-carry basis. In the Philippines, raising cattle under coconut using improved grass-legume pastures could generate a net profit of US\$510 per hectare annually while growing sheep will generate US\$ 127 and goat, US\$ 229. The number of animals raised per hectare was variable, depending on the available resources of the farmers.

To test the viability of this income generating intervention, the COGENT's poverty reduction project conducted farmer trials on poultry/livestock production to identify profitable options. The members of the community-based organizations (CBOs) in the 24 pilot communities were assisted, as individuals or in groups, to raise various poultry and livestock species. The project provided technologies, training, access to quality native and improved animal stocks, a revolving fund for microcredit, and marketing assistance. A total of 1593 CBO members, 58 % of whom are women, were involved in the production of quails, chicken, turkey, ducks, rabbit, goats, pigs and cattle. There were 185 participants in Bangladesh, 32 in Fiji, 370 in India, 82 in Indonesia, 126 in Papua New Guinea, 334 in the Philippines, 197 in Sri Lanka and 267 in Vietnam.

Loans were issued without collateral, in cash and in kind, to individuals and in groups. Interest rates, which ranged from zero to 15%, were decided by CBO officers in consultation with the members. Loan recovery rates are still difficult to estimate as most of the loans are not yet due, but based on current maturing loans, loan repayments have been as high as 95-100 %.

In India, farmers tending cattle have used the manure, in combination with farm waste, in vermicomposting (with earthworms) to produce and sell organic fertilizers, or applied to their farms to produce organically grown vegetables. In Vietnam, the cattle and pig manures were used to produce biogas for cooking and to fertilize Guinea grass grown under coconut for cattle fodder (Figure 5). This successful village-level technology could reduce the pressure on cutting forest trees for fuel wood and the area needed for open grazing. The biogas technology (Figure 5) has been replicated by the government agencies in 10 project sites.



Figure 5. Guinea grass being grown under coconut (*left*) for cattle fodder (*right*) in Vietnam. Biogas produced from cattle manure is used as fuel for household cooking.

The testing of animal integration with coconut farming is still in its infancy, but many CBO members have already adopted the introduced animal production technologies as components of sustainable livelihood activities. The initial results have tremendous potential, not only in generating income, but more so in improving nutrition. In Vietnam, farmers earn up to US\$159 in 3-4 months from chicken (fish and shrimp are also grown in

small canals or excavated areas between coconut); one housewife in Sri Lanka, who raises a milking cow with the help of her children, proudly stated that the cow produces 2.5 litres of milk a day from which the family consumes 1.5 litres and sells one litre per day. Mrs A. Shobhana, a housewife in Kasaragod, India who raises 10 chickens with the help of her 12-year old son, said that before the project, she could not afford to buy eggs at eight Rupees (US\$0.125) each to feed her children, but now she serves eggs everyday and still have some left for sale. In addition, poultry and livestock raising has fostered cohesiveness of family members working together to produce cash while improving their nutrition.

Community-managed production of high-quality planting materials

The success of planting of coconuts and intercrops depends to a large extent on the quality of seedlings used. To address this problem, there is a need to produce quality planting materials through community-managed seedling nurseries. This will not only ensure that high-quality planting materials will be affordable and available in adequate amounts at the community level but also provide additional source of income to participants.

At present, most of the coconut hybrids and varieties are produced by government-operated stations. The efficiency of production of coconut hybrids by farmers still needs to be evaluated. Thus, to complement the production of coconut seedlings by government stations, IPGRI/COGENT developed a model for a non-government dependent informal seed system at the community level (Figure 6). Through the poverty reduction project, farmers were trained to characterize and select desirable and high-value local coconut varieties through farmer participatory diversity fairs. Selected palms were paint-marked as sources of seednuts to be grown in community-managed nurseries. Owners of selected palms were given premium price for their seednuts. These seednuts were then grown by the participants of the seedling nurseries (usually 3-5 CBO farmer members/nursery) project in 6-9 months and then sold the seedlings among the community members. Profits were equally shared among the nursery participants. The results of this income generating activity are promising as described below.



Figure 6. Under the ADB-funded 'Poverty reduction in coconut growing communities' project, suitable local varieties were identified by the farmers' themselves with the help of coconut breeders (*above left*), then mother palms of selected varieties were paint-marked (*center*) and the seednuts from these mother palms were raised in the community-managed seedling nurseries (*right*).

In Bangladesh, the nursery group purchased 1500 seednuts worth US\$260, grew these in the nursery and generated a net group income of US\$ 145 after getting paid for their labour. In another Bangladesh community, a net income of US\$ 134 was shared. In India, a nursery group earned a net profit of US\$ 204 and another, US\$ 494. In the Philippines, a net income of US\$ 327 was earned by the nursery group and in Sri Lanka; the groups earned US\$ 330 in one community and US\$ 340 in another. Using this seedling propagation cum income

generating strategy, the project participants in 24 communities in eight countries were able to plant 64 521 high-quality seedlings in farmers' fields.

If newly released hybrid seedlings are available from government stations, the nursery group can similarly purchase the seednuts, grow them in the nursery and sell them after 6-9 months. The same strategy can be adopted to propagate and disseminate cash and food security crops which include root crops, vegetables and fruit crops. If properly organized and implemented, these community-based nursery activities will not only generate additional incomes for coconut farmers but also promote the conservation of high-yielding and adapted local varieties.

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Village-level production of high-value coconut products to enhance incomes of resource-poor coconut farmers

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Introduction

Coconut is widely known as the 'tree of life' due to its significant contribution to the human life from all of its parts: meat, husk, shell, wood, water, leaves, spikelet, etc. However, coconut farmers face two major problems: (1) low coconut farm productivity; and (2) unstable markets for the traditional commercial coconut products (i.e. copra and coconut oil). Hence, majority of coconut farmers are living below the poverty line.

To alleviate these problems, the International Plant Genetic Resources Institute (IPGRI), through its International Coconut Genetic Resources Network (COGENT) promotes the production and marketing of high-value products from coconut meat, husk, shell, wood, water and leaves to increase income of coconut farmers. The strategy is to diversify products derived from coconut and actively promote new value-added products, to utilize fully the potential of the crop.

In producing various high-value products, one has to consider the following: (a) size of nut; (b) thickness of fibre and shell; (c) meat (endosperm) quality; and (d) availability of seednuts from appropriate palms. Hence, there is a need to develop coconut hybrids with desired traits to further increase the total farm productivity and income. Coconut hybrids usually flower in 2.5-3.0 years after planting compared to the traditional tall varieties which take seven years to reach fruiting stage. Based on country reports in the previous chapters, the yield projection of coconut hybrids shows the production of up to 5 tonnes of copra (dried kernel) per ha⁻¹ year⁻¹ at the peak of production (at 10-12 years) compared to the one metric tonne of copra produced by the traditional Tall coconut varieties. The five-fold increase in yields of coconut hybrids will definitely increase the farmers' income.

Aside from increasing coconut yields through planting of hybrids, incomes can also be increased by processing the whole nut into primary products, followed by secondary products or high-value products to increase the coconut farmers' income. COGENT implemented a project on production and marketing of coconut high-value products in 2002-2004. Each participating pilot community were formed into a community-based organisation (CBO) to test the viability of producing coconut products from the fibre, shell, kernel, water and wood. This paper presents the project's initial results in Thailand, the Philippines and Vietnam.

Selecting profitable coconut high-value products

Before going into the production and marketing of high-value products, the project community coordinator and technical team conducted a market survey and pre-feasibility studies to determine the most marketable and profitable high-value coconut products for each community.

This was followed by a simple training needs survey, which enabled the community coordinator to analyze the current situation and capacity of project participants and their training needs. After the list of marketable and profitable products has been identified, the CBO members developed an action plan.

Based on the action plan, the community coordinator evaluated appropriate village-level machineries for the production of the selected high-value products and identified resource persons to conduct the trainings. A sample evaluation report of the project equipment in Fiji is shown in Annex 1.

At the end of the trial, a profitability analysis was undertaken to determine the income derived from each high-value coconut product. The results were used in comparing household and community incomes before and after the project.

Project results

The trained farmer, working as individual or in groups, produced value added products such as sugar and vinegar from sap; activated carbon and handicrafts from the coconut shell; nata de coco and wine from the coconut water; furniture and handicrafts from the coconut wood; beautiful baskets and hats from the coconut leaves; window blinds from the inflorescence; cooking oil, virgin oil, soap, candies and detergent from the coconut kernel; and ropes, geotextiles, doormats and many other products from the coconut husk (see Figure 1).

Tables 1, 2 and 3 show the types of product, net income at factory and household level in Thailand, the Philippines and Vietnam, respectively (Batugal 2000). These three countries studied high-value products that can be sold locally, estimated their income generation potential and profitability, and documented the production techniques. Based on the results of the studies, 17 high-value coconut products from Thailand, 18 from the Philippines and 14 from Vietnam, showed potential for increasing incomes of coconut farmers.

Based on the estimates shown in Table 1, village-level factories can earn net incomes ranging from US\$ 2857 per year (nata de coco) to US\$ 85 000 (canned coconut milk) per year. Individual home income ranged from US\$ 2.10 per day (10 midrib brooms per day) to US\$ 17.86 per day (coconut-based baking custard).

The same study in the Philippines indicated that the net income from US\$ 4 to US\$ 9.40 can be generated per person per day; and US\$ 50 to US\$ 59.36 per person per month (Table 2). Village-level processing enterprises can generate net incomes of up to US\$ 120 000 per year.

In Vietnam, a study on the estimated income from 14 coconut products, which could be sold in the domestic and export markets, indicated that a skilled farmer-processor could earn from US\$ 1 to US\$ 2.33 per day and a household could earn from US\$ 42.20 to US\$ 55.25 per month.

Annexes 2-9 present, in a catalogue format, the detailed illustration and general guidelines/ procedures for producing some high-value products from different parts of the coconut.

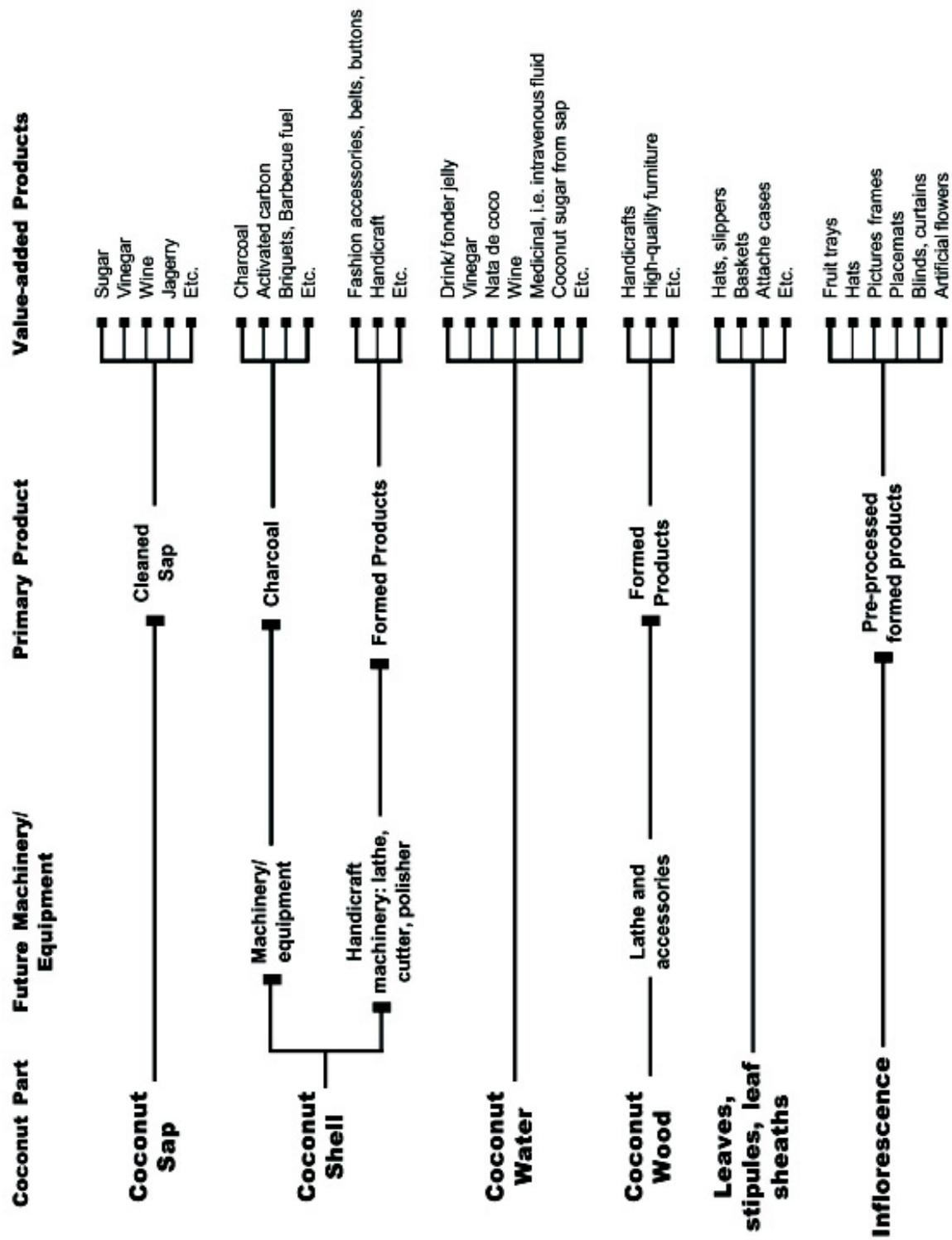
Conclusion

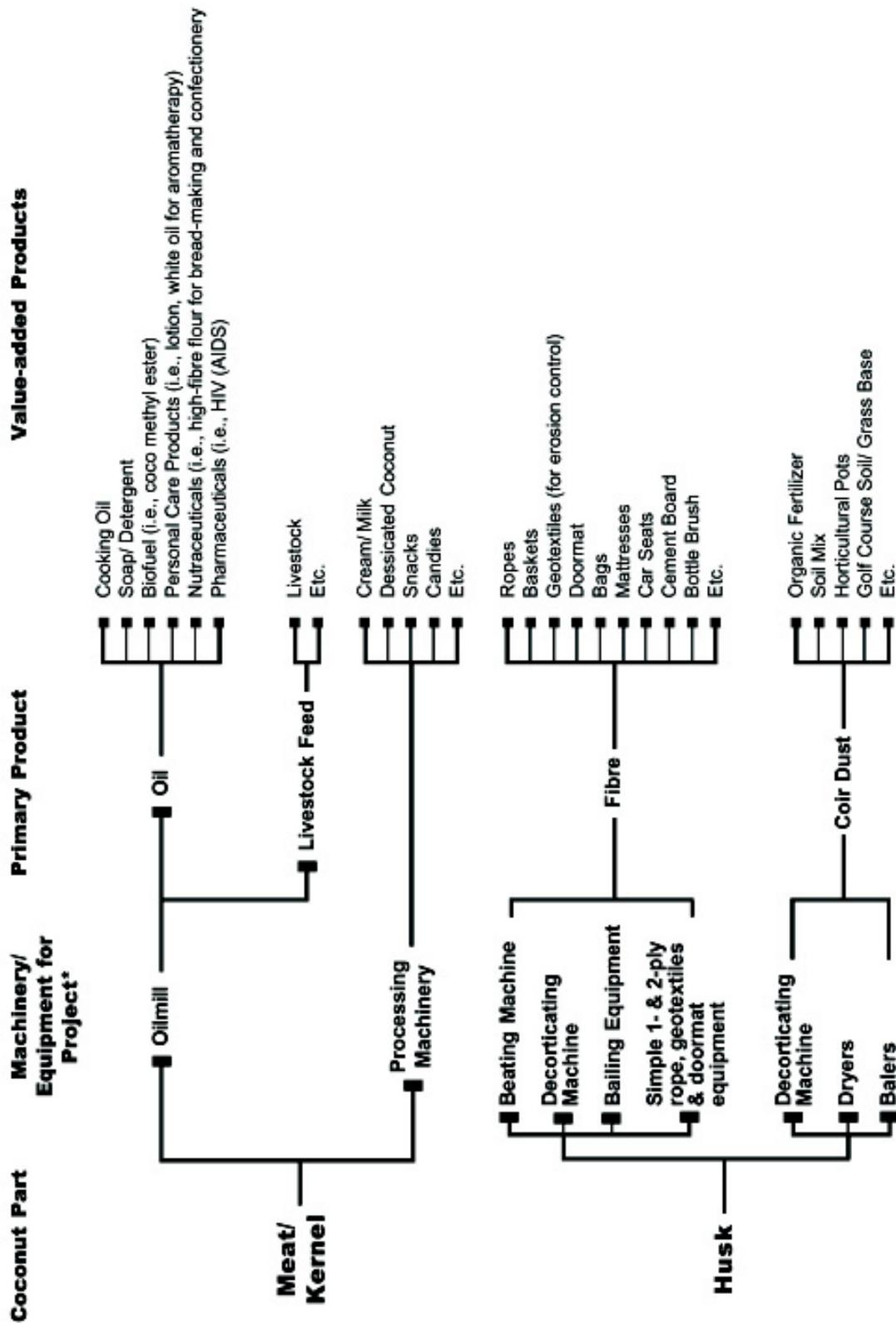
Previously, the poor coconut farmers could only earn at most US\$ 200 annual family income which is below the poverty line. The incomes shown in Tables 1 to 3 are two times more than the traditional income from copra (dried kernel). Thus, village-level diversification of coconut products could markedly increase farmers' incomes. Coupled with additional incomes from high-yielding hybrids, intercropping and animal/ forage production (as described in the preceding article), there is a potential for farmers to lift themselves above the poverty line.

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Figure 1. Income-generating technology scenario for producing high-value products from the different parts of the coconut (P Batugal and J Oliver 2003)





* Suitable for 300-500 household communities

Table 1. High-value coconut products from Thailand: Estimates of income and profitability (Peyanoot 2000)

| Products | Net Income (factory level) (US\$) | Net Income per unit/person/household (US\$) |
|------------------------------------|--------------------------------------|---|
| Coconut Shell and Wood Handicrafts | | 200-400/household/month |
| Coconut Fibre | 2715/month | |
| Coconut Monkey | | 4.20/piece |
| Coconut Midrib Broom | | 0.21/broom |
| Coconut Midrib Basket | | 0.19/basket |
| Coconut Calyx Flower | | 4.16/flower |
| Coconut Guinit Flower | | 4.00/flower |
| Coconut Chip | 3559/year | |
| Coconut Sugar | 2382/ha/year | |
| Nata de Coco | 238/ton or 2857/year | |
| Young Coconut with Opener | 17 565/week | |
| Canned Coconut Milk | 714/10 000 units or 85 000/year | |
| Coconut Nectar | 11.42/box of 24 bottles | |
| Roasted Young Coconut | 125/day | |
| Honey Roasted Coconut | 833/week | |
| Coconut Toffee | | 8.57/person/day |
| Coconut Baking Custard | | 17.86/person/day |

Table 2. High-value coconut products from the Philippines: Estimates of income and profitability (Carpio 2000)

| List of Products | Net Income (factory level) (US\$) | Net Income per unit/person/household (US\$) |
|--|---|---|
| Coconut Furniture Manufacture | ROI of 20% | |
| Coconut Wood Parquet Flooring | ROI of 15% | |
| Coir-wood-cement Board (CWCB) | 36 000/year | |
| Stitched Fibre from Mixed Coir Fibre | 24 000/year | |
| Beds from Manually Produces Coir Fibre | 51 064/year | |
| Mixed Fibre (CH-3 Grade) from Coconut Husk | 120 000/year | |
| Coconut Water Vinegar | 559/month | |
| Coconut Sap Sugar | 226.80/ha/month | |
| Macaroons | | 4/person/day |
| Coco Sap Syrup | 826/month | |
| Nata de Coco | 720/month | |
| Bukayo | | 11.80/household/day |
| Lambanog | 562/ha/month | |
| Coconut Burger | 80/day | |
| “Buko” Pie | | 23/household/day |
| Maja Blanca | | 9.40/person/day |
| Coco Spread | | 59.36/person/month |
| Coconut Cookies | | 50/person/month |

Table 3. High-value coconut products from Vietnam: Estimates of income and profitability
(Vo Van Long 2000)

| List of Products | Net income/unit/person/household (US\$) |
|--------------------------------|--|
| Handicraft from Coconut Shells | 34.50/ person/ month |
| Handicraft from Coconut Wood | 2.33/person/day |
| Coconut Shell Charcoal | 62.10/person/month |
| Coconut Midrib Baskets | 1.24/person/day |
| Coconut Single Ropes (Yarns) | 1.14/person/day |
| Coconut Coir Tapes | 1.20/person/day |
| Door Mats from Coir Fibre | 1.20/person/day |
| Snow Mats | 1.00/person/day |
| Geotextile | 1.30/person/day |
| Coconut Candies | 1.30/person/day |
| Coconut Paper Cakes | 1.30/person/day |
| Nata de Coco | 42.20/household/month |
| Coconut Cheese | 55.25/household/month |
| Coconut Yoghurt | 49.12/household/month |

Annex 1. Performance evaluation of COGENT machineries and equipment at Belego and Tukavesi in Savusavu, Fiji¹

In an effort to eradicate poverty in the coconut growing region, the International Coconut Genetic Resources Network (COGENT), which is administered by the International Plant Genetic Resources Institute (IPGRI) is promoting income-generating activities and on-farm conservation strategy for coconut through a 'Poverty reduction project in coconut growing countries'.

As part of this project, in March 2004, a decorticating machine and hydraulic oil expeller was installed at Belego and Tukavesi, respectively. An active participation by the members of the Community Based Organisation (CBO) at Belego and Tukavesi is imperative for the successful functioning of this project. As such, performance evaluations of both the machines were conducted and the skills of CBO members in producing coconut fibre produced were also assessed.

Performance evaluation of beating and decorticating machine at Belego

Coconut husks of assorted sizes were collected, counted, weighed and stock piled prior to the operation of the machine.

Beating Machine

| | | |
|--|---|-----------------|
| Total number of husks fed into the beating machine | = | 440 husks |
| Total weight of the husk | = | 283 kg |
| Beating time | = | 8 minutes |
| Beating rate of the machine | = | 55 husks /min |
| Total weight of husk after beating | = | 216.5 kg |
| Weight loss | = | 66.5 kg |
| Input : Out put Ratio | = | 1:1 |
| Production per unit time | = | 3300 husks/hour |

Decorticating Machine

| | | |
|--|---|--------------------------|
| Total number of husks | = | 440 husks |
| Decorticating time | = | 25 minutes |
| Decorticating rate | = | 17 husks/minute |
| Weight of fibre | = | 61.5 kg |
| Fibre yield per husk | = | 140 g |
| Total weight loss | = | 283 – 61.5 kg = 221.5 kg |
| Percentage weight loss | = | 78.3% |
| Production per unit time | = | 147.6 kg /hr |
| Relative capacity (beating : decorticating machine) | = | 1 : 3 |
| (i.e., 1 hour operation of beating machine provides enough husks to run a decorticating machine for 3 hours) | | |

21.7% of the husk contributes to fibre, 78.3% is coir dust

*Approximately 7 husks produce 1kg of fibre

In July 2004, the skills of farmers in using equipment for making single and double ply ropes and door mat making were assessed. The farmers weaved the door mat using their own local pattern.

¹ By Basdeo Lal, Senior Engineer, and Josua Sokobera, STA, Agricultural Mechanization, Fiji

Single-ply rope-making

| | | |
|--------------------------|---|------------------|
| Length of rope | = | 100m |
| Weight of fibre required | = | 1.0 kg |
| Time taken | = | 2 hrs 20 minutes |

Double-ply rope-making

| | | |
|------------------------------------|---|-------|
| Length of double ply rope prepared | = | 28 m |
| Time taken | = | 4 min |

Doormat-making

| | | |
|-------------------------------------|---|------------------|
| Length of double ply rope required | = | 63 m |
| Weight of rope | = | 750 g |
| Time taken to complete the door mat | = | 2 hrs 30 minutes |

Performance evaluation of coconut oil expeller at Tukavesi

One hundred nuts were collected from Wainigata Research Station from which 10 nuts were randomly picked for nut analysis. The nuts were husked, split open and grated. As there was no dryer provided for this project, a dryer had to be improvised. Wet kernel was dried and the machine was fed in two batches.

| | | |
|--|---|------------|
| Number of coconuts husked | = | 80 nuts |
| Husking time | = | 25 minutes |
| Grating time for randomly selected 10 nuts | = | 14 minutes |
| Weight of wet kernel | = | 9.346 kg |
| Drying time | = | 47 minutes |

Batch I

| | | |
|------------------------------------|---|------------------------------|
| Weight of dry kernel | = | 2.748 kg |
| Weight of oil cake | = | 1.926 kg |
| Operating pressure of oil expeller | = | 300 bars |
| Volume of oil collected | = | 750 ml |
| Weight of oil | = | 697.5g |
| Efficiency | = | $697.5 / (2748-1926) = 85\%$ |

Batch II

| | | |
|------------------------------------|---|-------------------------------|
| Weight of dry kernel | = | 2.970 kg |
| Weight of oil cake | = | 1.758 kg |
| Operating pressure of oil expeller | = | 300 bars |
| Volume of oil collected | = | 1.14 liters |
| Weight of oil | = | 1060.2 g |
| Efficiency | = | $1060.2 / (2970-1758) = 87\%$ |

Efficiency of hydraulic coconut oil expeller is about 87%

General observation

The use of machineries and equipment require skill. These skills have to be taught to the farmers through proper training sessions. The farmers would not be competent to handle machinery and equipment confidently unless they use them on a regular basis.

Annex 2. Making coconut candy (Vietnam)²



Coconut milk is extracted.



The coconut milk is mixed with refined sugar and boiled.



The mixture is poured and spread over an oil-lined tin surface with grooves of equal width.



When the mixture has cooled and hardened, it is removed from the grooves (in strips), cut into cubes and individually wrapped.



About 60 pieces of coconut candy are packed into a transparent bag with label. The packaged coconut candies are then delivered and sold in the market.

² By Mr. Vo Van Long, Coconut Scientist, Oil Plant Institute of Vietnam, Ho Chi Minh City, Vietnam

Procedure for making coconut candies

Coconut candy is a popular sweet in Vietnam. It is made at households or small confectionery units in villages or towns where coconuts are grown, especially in Ben Tre province. They can be found at any local markets, confectionery shops and at the ferry landings in Ben Tre and Can Tho. People usually buy them to offer to their relatives and friends in big cities as special gifts. A small quantity is also exported to the countries where many overseas Vietnamese are living.

The process of making coconut candies has three major steps:

1. Coconut kernels from mature nuts are grated and coconut milk is extracted.
2. The coconut milk is mixed with refined sugar and condensed by heating until the mixture obtains an appropriate thickness.
3. At this stage, other fruits or nuts such as dried bananas, coconut slices, roasted peanut pieces, can be added to create special flavours for the finished product.
4. The mixture is then poured and spread over an oil-lined tin surface with grooves of equal width.
5. The cooled and hardened mixture strips in the grooves are removed, cut into cubes and wrapped in colourful sweet wrappers.
6. About 60 pieces are packed into a labelled transparent bag, ready to be sold in the market.

Packaging

The profit earned from this product depends mainly on scale of production. Price of coconut candy in markets is 15 000 VND per pack and a person can earn 18 000 VND – 20 000 VND per day.

Annex 3. Producing coconut virgin oil (Sri Lanka)³



Scrape the kernel from the split nuts.



Dry the desiccated coconut in a saw dust fuel drier.



Put the dried desiccated coconut in a presser/ expeller to extract the coconut virgin oil.



Dried desiccated coconut.



Pack and seal the extracted virgin coconut oil in bottles.

³ By Mr. Ajith Samarajewa, Research Officer, Coconut Research Institute, Lunuwila, Sri Lanka

Procedure for making virgin coconut oil

Virgin coconut oil is the naturally processed product from fresh coconut meat, which has not undergone any further processing. It is an ideal product to be used in therapeutic practices, apart from the common uses of coconut oil. In Sri Lanka, virgin coconut oil production is a novel process. However, realizing the natural goodness of the product, it rapidly gains popularity among the consumers.

Production of virgin coconut oil

Virgin coconut oil production is done through direct processing of fresh coconut meat using specific equipment designed for the purpose. The procedure involves several steps.

The materials needed to produce virgin coconut oil are, fresh coconut meat; virgin oil expeller; dryer; filters and double jacket kettle

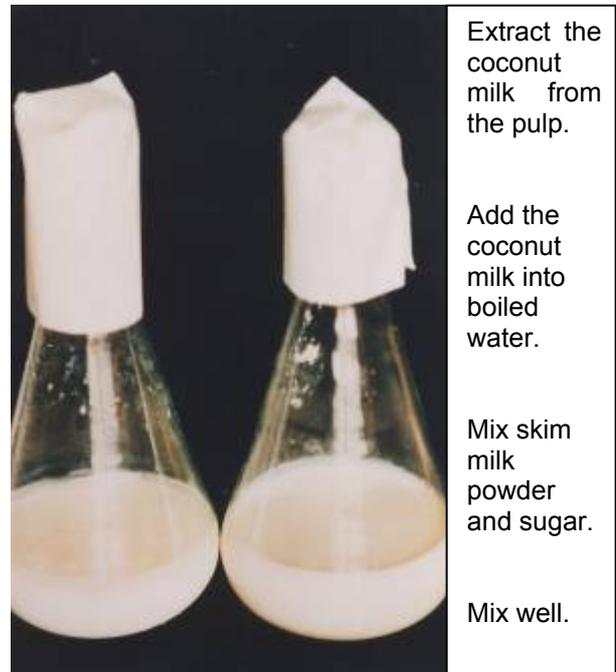
- a. Preparation of fresh coconut meat: Fresh coconuts seasoned for about 5 weeks are de-husked. The split nuts are scraped immediately and dried in the sun or using a saw dust fuel drier to reduce its moisture content up to 8-10 %.
- b. Expelling of virgin coconut oil: Semi dried coconut meat is loaded into the stainless steel cylinder of the expeller. The cylinder is fixed to a hydraulic press and full force is applied on the top of the feed to expel virgin oil.
- c. Settling and filtering of oil: Pressed oil is poured into settling tanks to separate sediments. Decanted oil is then subjected to a mild heat treatment in a double jacketed kettle and filtered.
- d. Bottling is done in plastic containers.

Packaging

The pure virgin coconut oil is bottled in two quantities; 100 ml and 500 ml in plastic bottles, labeled and dispatch for marketing to be used by the consumers

This system can produce 10-11 liters of virgin oil using 80 coconuts within eight hours. The production cost involves for coconuts, labor and the electricity and sawdust cost for the drier. The estimated production cost for a liter of virgin coconut oil is about US\$ 1.1. At a selling price of US\$ 1.7 per liter, one can earn a profit of US\$ 0.6 per liter of oil or US\$ 6.3 per day. The product is sold in super markets and other general merchandise shops.

Annex 4. Making coconut yogurt (Vietnam)⁴



⁴ By Mr. Vo Van Long, Coconut Scientist, Oil Plant Institute of Vietnam, Ho Chi Minh City, Vietnam

Procedures for making coconut yogurt

Coconut yogurt is a nutritious product made from coconut milk and skim milk powder, fermented with lactic acid bacteria. It contains 3.3% protein, 4% fat and 12% sugar. It is easily assimilated in the body system and possesses therapeutic properties.

Process Flow

1. Select good quality nuts.
2. Remove all adhering fibres on the nut and sanitize with chlorine solution before splitting into half.
3. Grate the coconut pulp finely by coconut grater.
4. Extract the coconut milk.
5. Add the coconut milk into boiled water. Stir in skim milk powder and sugar. Mix well.
6. Pasteurize the mixture at 85°C for 20 minutes.
7. Inoculate starter culture after having quickly cooled the mixture to 42°C.
8. Transfer the inoculated milk into suitable packaging material. Incubate at 42°C for 4 hours.
9. Store in refrigerator.

Packaging

This product is made at household level. The total cost of production for 250 pieces of coconut yogurt is 375 000 VND. One can earn a profit of 171 800 VND by producing 250 pieces of coconut yogurt.

Annex 5. Making coconut fibre-based single-ply ropes (Vietnam)⁵



Dehusked fibres are sun-dried.



Single-ply rope-making machine (manual and motorized combined)



The fibres are spun and twisted into a continuous single-ply rope. More fibres are added until desired length is achieved.

The finished products are then packed and shipped.



The single rope is rolled automatically on a horizontal bar as it exits the rope-making machine.



⁵ By Mr. Vo Van Long, Coconut Scientist, Oil Plant Institute of Vietnam, Ho Chi Minh City, Vietnam

Procedure for making coconut fibre-based single-ply ropes

Single ropes or yarns are the simplest product made from coconut fibres. They are used as a base material for various export fibre commodities including double yarns, mats, geotextile nets, etc. Therefore the demand for this product is rather high in local markets.

The process of making this product consists of three main steps:

1. Green husk are shredded and beaten by decorticating machines. These are then sun-dried until they reach suitable moisture.
2. The dried fibres are drawn out by hand to feed a one-ply rope making machine. The fibres are spun and twisted into a single thread. The rope making machine is operated by foot or by motor. The single rope is rolled automatically on a horizontal bar at the exit of the rope making machine.
3. The temporarily rolled rope is collected and made into rolls of finished product by using a simple rotating cylinder which has a lid that can be removed to let the roll drop out. The finished products are rolled uniformly and packed at the same size.

Packaging

At household level, the output is usually about 12 - 15 kg of rope per machine per day and the worker can earn 1000 – 1400 VND per kg of product. Farmers usually make this product by using their income and sell their product to cooperatives or factories that produces mats, ropes, nets, and etc. Sometimes, the farmers are sub-contracted to produce these rope yarns base on number of units that is completed.

Annex 6. Making coconut fibre-based double ply ropes (Vietnam)⁶



Two pieces of single-ply ropes are stretched about 20-30 m far then tied together at their ends.



The tied ends of the two single-ply ropes are fixed to the rotational hook of the twister.



The double-ply ropes are then rolled into a yarn, packed and shipped.



The twister is then run until the two single-ply ropes are tightly spun together. The twister could be run by hand or by using a 1/4 hp motor.

⁶ By Mr. Vo Van Long, Coconut Scientist, Oil Plant Institute of Vietnam, Ho Chi Minh City, Vietnam

Procedure for Making Coconut Double-Ply Ropes

Double-ply ropes is mostly used similar with single-ply rope, i.e. in making geotextile net and coco-log, as a sturdy or strong material to stabilize the soil and control soil erosion.

The process of making this product consists of five main steps:

1. Stretch two separate strings of single-ply ropes 20-30 m far then tie both ends together.
2. Fix the tied end of the strings to the rotational hook of the twister.
3. Run the twister until the two single-ply ropes are tightly spun together. The twister can be operated either by hand or by a 1/4 hp motor.
4. Remove the spun double-ply ropes from the twister then roll into yarns.

Packaging

The estimated output in producing double-ply rope at the household level is 80 kg per worker per 8-hour work. The average selling price is 4000 VND per kg. With the average cost of production of 3000 VND, a farmer/worker can earn 80 000 VND in a day or roughly US\$5.20.

Annex 7. Making coconut fibre-based geotextile (Vietnam)⁷



Double-ply fibre ropes are used as base material for making geotextile.



The ropes are woven into nets using a simple, usually wooden, weaving tool.



Two workers sit at the edges of the net to direct the shuttle forwards and backwards through the longitudinal strings.



The simple wooden weaving tools



The completed nets are rolled and ready for export.

⁷ By Mr. Vo Van Long, Coconut Scientist, Oil Plant Institute of Vietnam, Ho Chi Minh City, Vietnam

Procedure of making geotextile

Besides the traditional products such as yarns, mats and ropes, coir fibre can be made into new products such as geotextile nets and coir tapes. Geotextile nets are used as mulches to protect soils from erosion. This new product is made mainly for the export market.

The process of making this product consists of two major steps:

1. Double-ply coir ropes are used as base material for making this product. The ropes are woven into nets using a rough weaving tool. This tool is operated by two workers who sit at the edges of the net to direct the shuttle forwards and backwards through the longitudinal strings.
2. The completed nets are rolled and ready for export. Their size depends on the requirements of the buyers.

Packaging

Compared to other coir products, geotextile has a higher value and a brighter future thanks to its promising foreign markets. At a household level, one worker can make about 60 meters per day under sub-contracting and get paid on the basis of the production quantity. A skilled worker can earn 20 000 VND a day.

Annex 8. Making coconut shell-based earrings (Thailand)⁸



Cut and polish a half coconut shell.



Draw the earring patterns on paper and stick them onto the polished coconut shells.



Cut out the pattern using a hand held fret saw.



Further polish the final product, apply acrylic lacquer for gloss and attach the earring hooks.

⁸ By Ms. Peyanoot Naka, Post Harvest-Processing Specialist, Department of Agriculture, Bangkok, Thailand

Procedure for making coconut earrings

One of the various handicrafts or accessories that can be made from coconut shell is coconut earrings. This small delicate product may look easy to produce but it actually requires much skill and patience.

Steps on the making procedures:

1. Cut and polish a half coconut shell.
2. Draw earring patterns on paper and stick these on the polished half shell.
3. Cut out the patterns or shapes using a fret saw.
4. Smooth the cut pattern using sand paper.
5. Apply acrylic lacquer for gloss.
6. Air-dry the finished products then attach the hooks to complete the earrings.

Packaging

The cost of production includes those of the coconut shell, blade for fretsaw, lacquer, sand paper, silver hooks and electricity. Labour cost is not included because it is done in households. The selling price of a pair of earrings is 20 baht/piece and the average net income is 15.19 baht/piece.

Annex 9. Making coconut shell-based spoons (Thailand)⁹



Draw a spoon shape on a half coconut shell.



Cut out the drawn spoon pattern using a bench grinder.



Polish the cut pattern using a rotary sanding machine.



Connect the wooden handle to the polished spoons using glue. Secure further by using copper wires.



Apply acrylic lacquer to make the spoon shiny. Prepare wooden handles for the spoons.

⁹ By Ms. Peyanoot Naka, Post Harvest-Processing Specialist, Department of Agriculture, Bangkok, Thailand

Procedure for making coconut spoon

Coconut spoons are made from coconut by-products. These products are consumed in the domestic and export markets (such as Canada, Italy, Germany, Sweden, Holland, etc.). Coconut varieties such as Thailand Tall, Sawi hybrid No.1 and West African Tall are suitable varieties for producing coconut-based handicrafts.

Steps on the making procedures:

1. Select a half coconut shell.
2. Draw the spoon shape on the half coconut shell.
3. Cut the spoon pattern using a bench grinder.
4. Polish the cut spoon pattern using a rotary sanding machine or sand paper.
5. Apply acrylic lacquer to spoons to make them shiny. Prepare wooden handles for the spoons.
6. Connect the wooden handles to the shell spoons with glue. Further secure using copper wires.

Packaging

The cost of production includes those of the coconut shell, the wood handle, sand paper, and electricity. Labour cost is not included because it is done in households. The selling price of a spoon is 15 baht/piece and the average net income is 10.62 baht/piece.

Annex 9. Making animal-shaped coconut fibre-based doormats (Vietnam)¹⁰



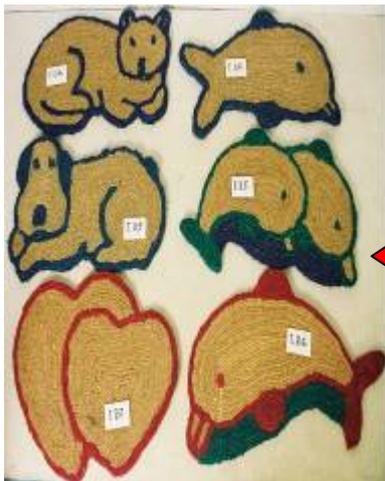
Preparing the 'twin-ropes'



Four to five meters long twin-rope produced



Weaving the twin ropes according to drawn pattern, using nails on wooden board as guide



Some of the finished products



Sewing the mat horizontally and vertically



Inserting coloured twin-ropes according to design

¹⁰ By Mr. Vo Van Long, Coconut Scientist, Oil Plant Institute of Vietnam, Ho Chi Minh City, Vietnam; pictures courtesy of Mr. Ajith Samarajeewa, Research Officer, Coconut Research Institute, Lunuwila, Sri Lanka

Procedure for making animal-shaped doormat

Animal-shaped doormat is just one of the many attractive products that can be made from the coconut fibre. It is used either for wall decoration or as a mat placed at the entrance of a house to wipe dirt from the shoes or slippers. In Vietnam and Sri Lanka, these animal-shaped doormats are very popular among local and foreign tourists and are mostly made for export.

Preparing the 'twin-ropes'

Single-ply coconut ropes mixed with some jute ropes are used to make twin ropes. The coconut rope is weaved around the jute rope to produce twin ropes of about 4-5 meters long each. Depending on the design preferences of the customers, twin-ropes can be dyed with different colours.

Weaving the doormat

The materials required include a wooden frame, nails, hammer, scissors, big needle and chalk.

- a. Draw the desired animal shape on the wooden frame using chalk.
- b. Weave the twin ropes into the frame following the animal shape you drew. Use nail and hammer as necessary to make the weave secure and compact. Continue weaving the twin-ropes towards the inside of the pattern. For design, use colored twin-ropes at the border first and secure them into the shape with nail and hammer. Remove nails as you weave from layer to layer into the shape.
- c. Use coloured twin-ropes in the relevant portions of the doormat based on the design.
- d. When the doormat is completed, sew it horizontally and vertically using a big needle and jute rope, making sure that the doormat will not fall apart when taken out of the frame. Clean by cutting the extra fibres protruding from the doormat.

Packaging

Finished products are usually packed in cartons or boxes for delivery to customers.

One doormat maker can produce an average of 10 animal-shaped doormats per day. The estimated average production cost per doormat is US\$0.57 (US\$0.45 for materials and US\$0.12 for labour). At a selling price of US\$0.78, one can earn a gross profit of US\$0.21 per piece or US\$2.10 per day. Animal-shaped doormats could be sold in handicraft and souvenir shops, flea markets, department stores and general merchandise shops.

