

VALUE CHAIN OF PROCESSING OF COCONUT INTO BIOFUEL (COCO-METHYL ESTHER) IN THE PHILIPPINES

Sustainability Assessment of Biomass Utilization in East Asia

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ERIA

- This paper was part of the results of one of the Case Studies conducted
- under the Sustainable Biomass Utilization Vision in East Asia Project
- Funded by the Economic Research Institute for ASEAN and East Asia (ERIA)
- With Dr. Sagisaka Masayuki as team leader
- Coordinated by the Japan External Trade Organization (JETRO)

ERIA

- Economic Research Institute for ASEAN and EAST Asia (ERIA)
- ERIA is a new international organization that supports the ASEAN Secretariat
- Through its policy recommendations at regional governmental meetings such as East Asia Summit,
- aimed at furthering East Asia's economic integration

Working Group of ERIA

- Working Group is formed to conduct Case Studies in support of the Working Group Report
- Developed ERIA Report leading to development of policy recommendations for consideration of EAS Energy Ministers
- Provide copy of the report for the EAS Energy Ministers meeting
- Conduct further studies as needed by EAS

APPRECIATION OF EAS ENERGY MINISTERS

- The East Asia Energy Ministers during the EAS Energy Ministers Meeting held on August 2008 in Bangkok endorsed the “Asia Biomass Energy Principles”
- for production and utilization of environmentally and socially sustainable biomass energy in the region.

APPRECIATION OF EAS ENERGY MINISTERS

- Request of East Asian Ministers to develop a methodology for assessment of environmental and social sustainability in production and utilization of biomass taking into account specific regional circumstances.

ERIA PHASE 2

- “Sustainability Assessment of Biomass Utilization in East Asia”
- Develop Guidelines for Indicators of Economic, Environmental and Social Impacts of Biomass Utilization in East Asia
- Funded and coordinated by the National Institute of Advance Industrial Science and Technology (AIST)

**VALUE CHAIN OF PROCESSING
OF COCONUT INTO BIOFUEL
(COCO-METHYL ESTHER)
IN THE PHILIPPINES**

INTRODUCTION

- Philippines has been very dependent on imported fossil fuel for energy use.
- In 2006, 55.83% of the country's total energy mix was contributed by the indigenous sources while the remaining 44.17% from imported fuels (DOE PEP, 2006) .
- Among the imported fuels, oil imports registered the largest contribution with 33.84%.

INTRODUCTION

- For the indigenous sources, biomass registered the largest contribution of 31.84% to total energy supply.
- This is followed by geothermal and natural gas with 6.70% and 6.42% respectively.
- Though efforts in the promotion of CME and Ethanol are rigorous, no contribution from these sources was recorded in 2006 .

INTRODUCTION

- The most common biomass resource in the Philippines is coconut.
- For 2008, the Philippine Coconut Authority (PCA) data accounts that 3.37 million hectares out of the 12 million hectares of farmlands are devoted to coconut.
- The country has a 59% share in world coconut exports and is the world's second largest producer of coconut products after Indonesia.
- The industry contributes an annual average of 5.97% to Gross Value Added (GVA) and 1.14% to Gross National Product (GNP).

INTRODUCTION

- Regarded as a dominant sector of Philippine agriculture, the coconut industry is one of the major dollar earners of the country, averaging US\$800 million annually according to the Department of Agriculture (DA).
- The Philippines is the world leader in coconut oil production, supplying 64% of the global requirement (Teves, 2003).
- Approximately 80% of domestic coconut production is exported mostly to the US and Europe.

VALUE CHAIN

- This paper primarily determined the economic contribution of biomass production and utilization from coconut in the Philippines in terms of value addition from one product form to another.
- Thus this paper presents the value chain of the production of biofuel - coco-methyl ester as the final product from coconut.
- Value chain involves the determination of the value added generated for each conversion process for all the products.

VALUE CHAIN

- Value added refers to the additional value of a commodity over the cost of commodities used to produce it from the previous stage of production.
- Value addition translates to profit maximization generated out of a specific product form or industry.
- This could be achieved through product conversion or processing.
- The more processes a product undergoes, the higher value addition accumulates to it.

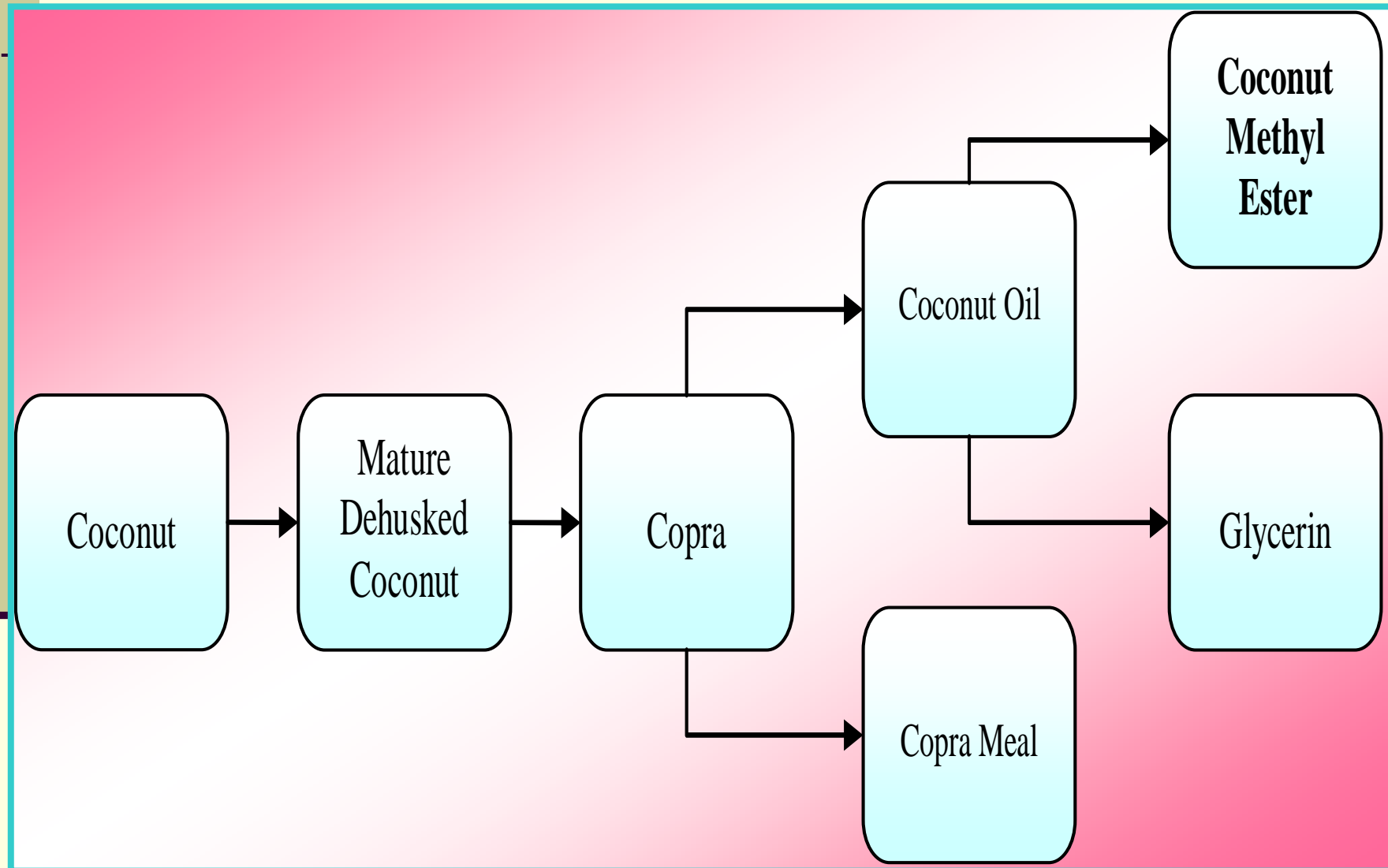
VALUE CHAIN

- The value added generated for each conversion process for all the product forms is shared among the different stakeholders who provide the services and factors of production (capital, labor, also human capital).
- Thus, the costs of these services are determined for each product form.
- The selling prices of each product form serve as the input price for the production of other product forms.

VALUE CHAIN

- The different product forms of coconut were considered. Primary coconut products include coconut oil, fresh and mature coconut, and copra.
- In the production of the final product which is coconut methyl ester (CME), mature dehusked coconut is used for copra production.
- Coconut oil is extracted from copra which will be the primary input in CME manufacturing.
- Throughout the conversion process, two by-products are generated namely copra meal and glycerin (see Figure).

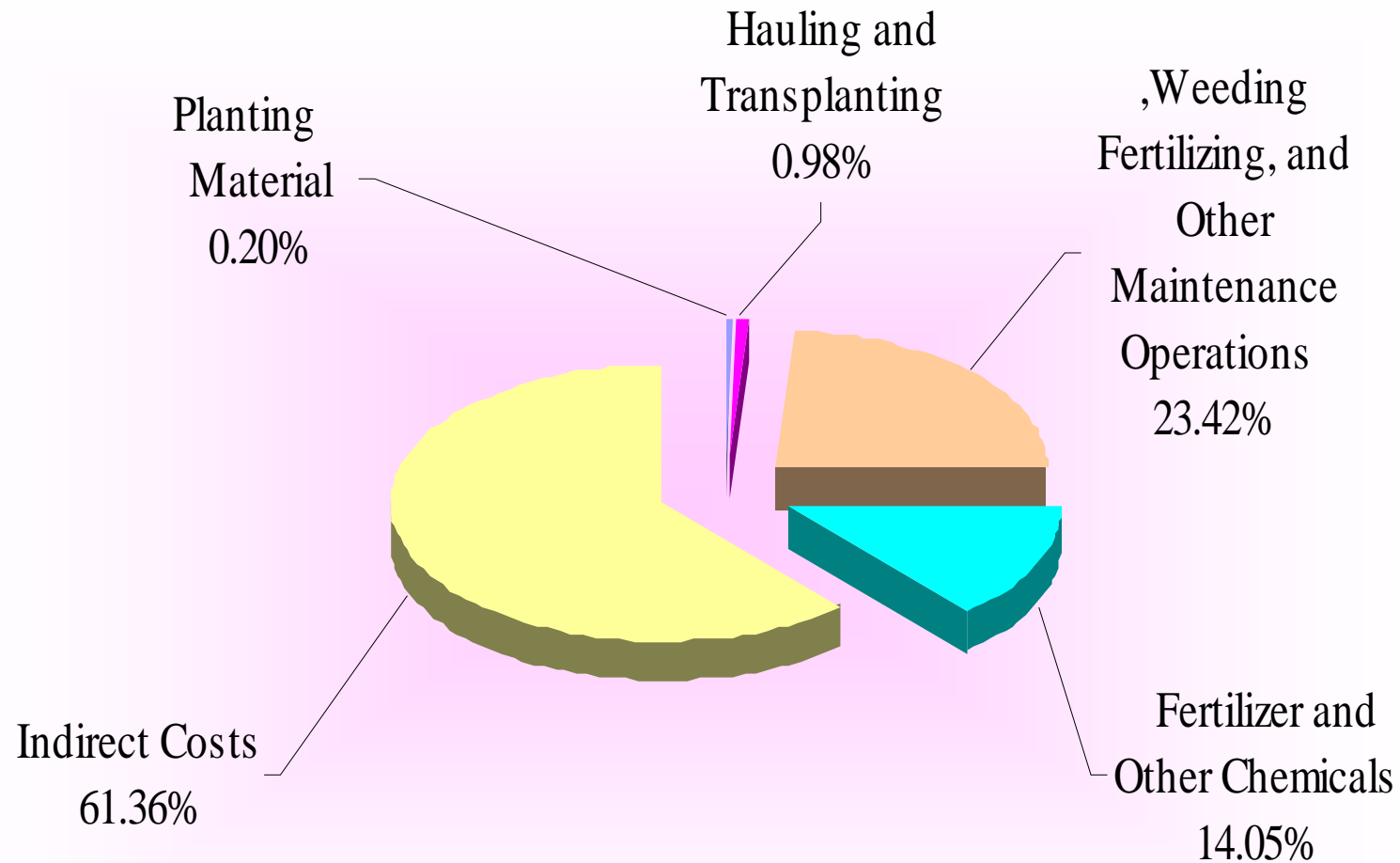
Product flow of coconut



FRESH NUT PRODUCTION

- 100 trees/ha, 10 fresh nuts/tree/ harvest
or a total of 1000 nuts per harvest.
- Six harvests/year = 6000 nuts/year/ha.
- 1 fresh nut weighs 1.5 kg
- Total output per year = 9,000 kg fresh nut.
- Cost of fresh nut = PhP1.43/kg
- Selling price of fresh nut = PhP2.33/ kg.
- Profit = PhP0.91/kg =US\$0.0189 (\$1=PhP48)

PRODUCTION COSTS OF COCONUT



MATURE NUT PRODUCTION

- The raw material in copra is mature dehusked coconut.
- Mature coconut is 90% of fresh coconut by weight and 27% of fresh coconut is husk,
- 1kg mature coconut = 1.59 kg of fresh coconut
- The cost per kg of a mature nut = PhP2.26.
- Cost of dehusking = PhP0.16 /kg of mature.
- Total cost per kilogram of mature nut = PhP2.42.
- Selling price of mature nut = PhP5.00/kg
- Value added or net profit = PhP2.58/ kg or **US\$0.116/kg** (\$1=PhP48)

COPRA PRODUCTION

- Copra is dried coconut meat from which coconut oil is obtained.
- The mature coconuts are split open then undergoes a drying process using dryers.
- Drying is the method of producing copra. The process of drying is characterized by the “dissolving” of moisture, which comes from the coconut meat, by air.

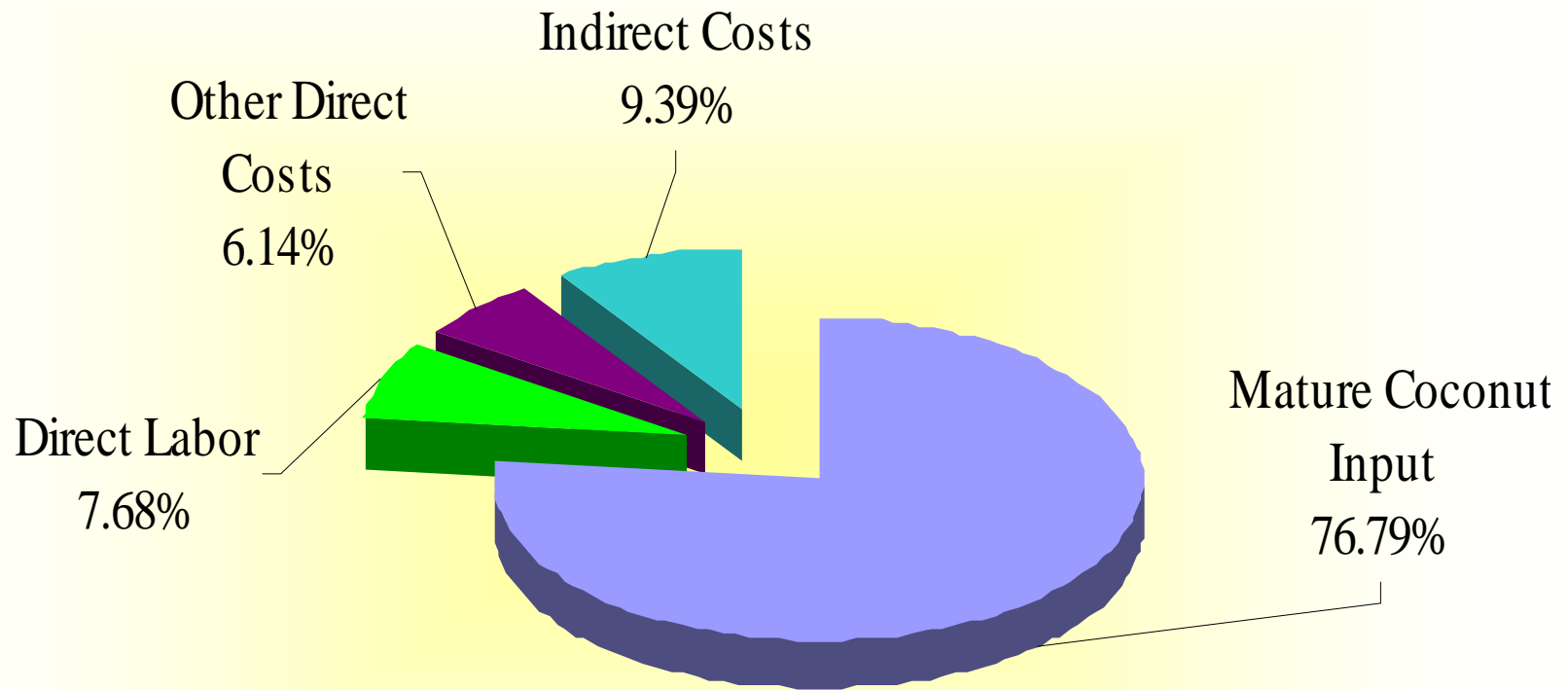
COPRA PRODUCTION

- The equilibrium moisture content of copra is about 5% which implies that good quality copra is attained when moisture content is at this level.
- After drying, the meat is scraped out.
- The coconut shell is collected and used as fuel for the earthen dryers.

COPRA PRODUCTION

- 40% of mature coconut is copra.
- Mature dehusked coconut serves as the primary input.
- Input cost = PhP5.00/kg of mature nut.
- Cost of copra=PhP16.28/kg
- Selling price of copra = PhP18.00/kg
- Value added is PhP1.72/kg or **US\$0.0358/kg**

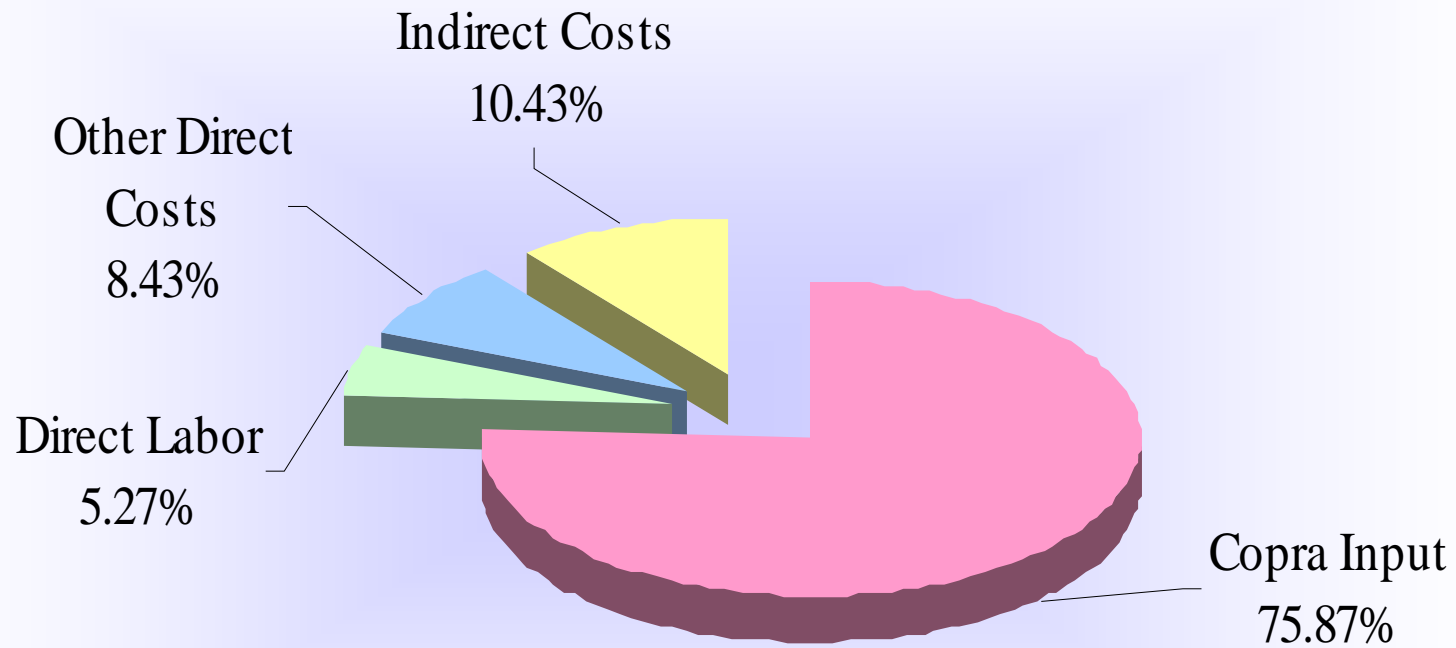
Costs in copra production



COCONUT OIL PRODUCTION

- The main input is copra
- Copra is crushed into cube size pieces and coconut oil is extracted from it using an oil expeller.
- 90% of copra is unrefined or crude coconut oil
- The remaining 10% is copra meal which is a by-product
- Copra is purchased from the copra dealers at PhP18.00/kg.

Costs in unrefined oil production



COCONUT OIL PRODUCTION

- Total cost = PhP26.36/kg
- Selling price of unrefined coco oil = PhP32.00/kg
- Selling price of copra meal = PhP6.00/kg
- Value added/profit = PhP5.64/kg or **\$0.1175**
- PhP 0.60 worth of copra meal as by-product is produced from a kilo of copra
- No costs accrue to it ,therefore, the sale of copra meal is just added to the profit

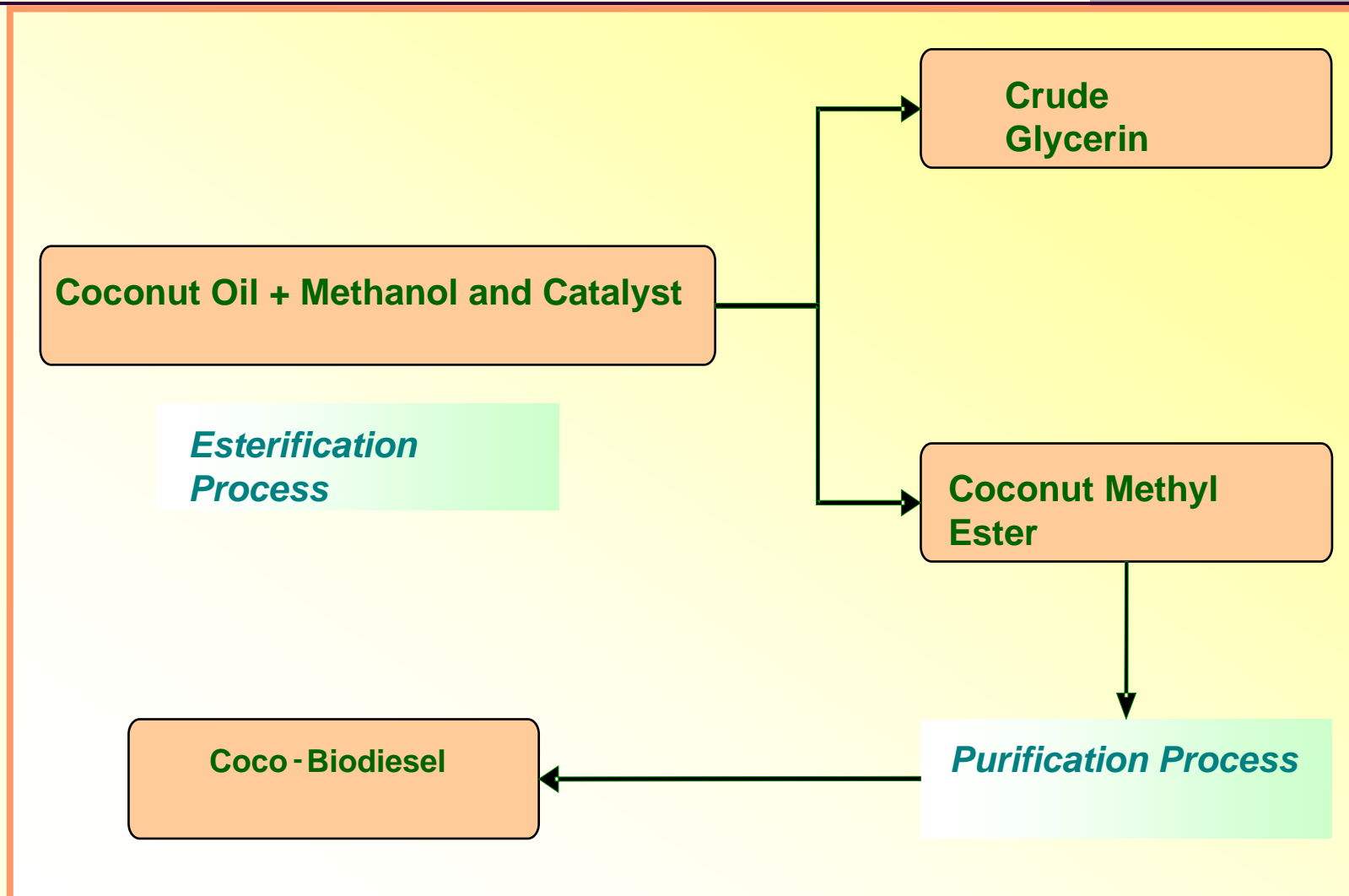
COCONUT METHYL ESTER (CME) PRODUCTION

- Coconut oil is the primary input in ester production.
- Other inputs include methanol and a catalyst such as caustic soda.
- These undergo esterification which is the process of transforming coconut oil into a liquid fuel (see Figure)
- Coconut oil is reacted with methanol in the presence of a catalyst.

COCONUT METHYL ESTER (CME) PRODUCTION

- The basic esterification of coconut oil and methanol with the presence of caustic soda as the catalyst can be done in a reactor at 60°-80°C with continuous agitation.
- After one hour, agitation is stopped and separation is seen.
- To neutralize the caustic soda, hydrochloric acid is added.
- After neutralization, the by-product crude glycerol settles at the bottom.

The esterification process in CME production



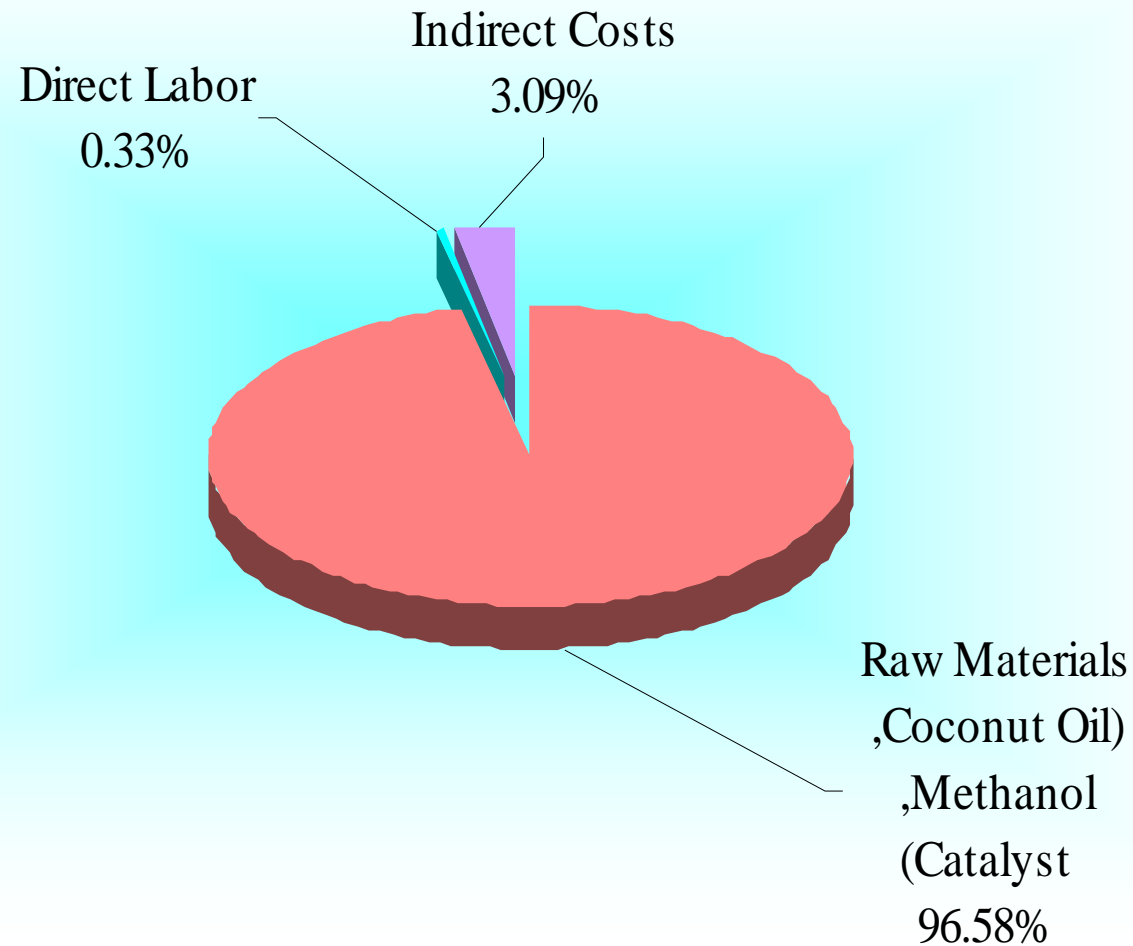
COCONUT METHYL ESTER (CME) PRODUCTION

- The recovery rate of CME from unrefined oil is 100%.
- Cost of unrefined oil = PhP32.00/kg or PhP29.28 per liter using the density of coconut oil which is 0.915 kg/L.
- Total cost per liter of CME is PhP36.84
- CME is sold at PhP40 per liter or PhP46.51 per kilogram using the density of CME which is 0.86 kg/L.

COCONUT METHYL ESTER (CME) PRODUCTION

- Value added/ profit = PhP3.16/liter or **\$0.0658**
- The sale of by-product glycerin adds to the profits
- Recovery rate of glycerin at 12.5%,
- Selling price is PhP28.00/kg
- Additional profit = PhP3.50/ kg or **\$0.0729.**

costs in coconut methyl ester production



TOTAL VALUE ADDED

- Final value added is the sum of partial value added and the value added generated from the by-products.
- By-products include
 - coconut husk from mature nut production
 - coconut shell from copra production
 - copra meal from unrefined oil production
 - and glycerin from methyl ester production.

TOTAL VALUE ADDED

- All values were computed based on one kilogram of mature coconut input.
- Producing 0.40 kilogram of copra (40% recovery rate)
- Such amount of copra would be able to produce 0.36 kilogram of unrefined oil (90% recovery rate).
- Such amount of oil would be able to produce 0.36 kilogram of methyl ester (100% recovery rate).

Summary of value added by product form produced from a kilo of mature coconut

PRODUCT FORM	SELLING PRICE	QUANTITY OF OUTPUT	GROSS REVENUE	PRODUCTION COST	Partial Value Added
	(in PhP/KG)	(in KG)	(in PhP)	(in PhP)	
Mature Coconut	5	1	5	2.42	2.58
Copra	18	0.4	7.2	6.51	0.69
Unrefined Oil	32	0.36	11.52	9.49	2.03
Coconut Methyl Ester	46.51	0.36	16.74	14.68	2.06
TOTAL VALUE ADDED				\$0.15	7.36

Summary of value added from by-products produced from a kilo of mature coconut

PRODUCT FORM	QUANTITY OF OUTPUT (in KG)	Value Added from By-Products				VALUE ADDED
		Coconut Husk	Coconut Shell	Copra Meal	Glycerin	
Mature Coconut	1	1.09	—	—	—	1.09
Copra	0.4	—	0.19	—	—	0.19
Unrefined Oil	0.36	—	—	0.24	—	0.24
Coconut Methyl Ester	0.36	—	—	—	1.26	1.26
TOTAL VALUE ADDED					\$0.06	2.78

Total value added by product form and by-products produced/kilo of mature coconut

PRODUCT FORM	SELLING PRICE	Partial Value	By-Product	Final Value
	(in PhP/KG)	Added	Value Added	Added
Mature Coconut	5	2.58	1.09	3.67
Copra	18	0.69	0.19	0.88
Unrefined Oil	32	2.03	0.24	2.27
Coconut Methyl Ester	46.51	2.06	1.26	3.32
TOTAL VALUE ADDED		7.36	2.78	10.14
				\$0.21

TOTAL VALUE ADDED

- The value additions accumulate to different entities along the marketing chain.
- This is so because each product form is bought and sold by several unrelated entities.
- The manufacturers of each product form receive value additions from the sale of each own product.
- Thus, the value added of PhP10.14 or **US\$0.211** (exchange rate: \$1= PhP48) per kg serves as the final value added from the start of the conversion process up to the final product

Summary of value added by product form produced from a hectare of mature coconut

PRODUCT FORM	SELLING PRICE	QUANTITY OF OUTPUT	GROSS REVENUE	PRODUCTION COST	Partial Value Added
	(in PhP/KG)	(in KG)	(in PhP)	(in PhP)	
Mature Coconut	5	5,670	28,350	13,721	14,629
Copra	18	2,268	40,824	36,921	3,903
Unrefined Oil	32	2,041	65,318	53,806	11,512
Coconut Methyl Ester	46.51	2,041	94,936	83,262	11,674
TOTAL VALUE ADDED				\$869.13	41,718

Summary of value added from by-products produced/hectare of mature coconut

PRODUCT FORM	QUANTITY OF OUTPUT (in KG)	Value Added from By-Products				VALUE ADDED
		Coconut Husk	Coconut Shell	Copra Meal	Glycerin	
Mature Coconut	1	6,180	—	—	—	6,180
Copra	0.4	—	1,077	—	—	1,077
Unrefined Oil	0.36	—	—	1,361	—	1,361
Coconut Methyl Ester	0.36	—	—	—	7,144	7,144
TOTAL VALUE ADDED					\$328.38	15,762

Total value added by product form and by-products produced/ha of mature coconut

PRODUCT FORM	SELLING PRICE	Partial Value	By-Product	Final Value
	(in PhP/KG)	Added	Value Added	Added
Mature Coconut	5	14,629	6,180	20809
Copra	18	3,903	1,077	4980
Unrefined Oil	32	11,512	1,361	12873
Coconut Methyl Ester	46.51	11,674	7,144	18818
TOTAL VALUE ADDED		41,718	15,762	57,480
				\$1,197.50

TOTAL VALUE ADDED/ha

- Quantity of output was computed by multiplying the per kilogram values by 945 kilograms of mature nut produced per hectare multiplied by six harvests in a year.
- Final value added amounts to PhP57,481 or **US\$1,197.52/ha** production of mature coconut processed into coconut methyl ester.
- These value additions are distributed among the different entities in the coconut industry.

CONCLUSIONS

- The final value added amounted to PhP10.14 or **US\$0.211** per kilogram of mature coconut processed into coconut methyl ester (PhP57,481 or **US\$1,197.52** per hectare of mature coconut processed into coconut methyl ester).
- The computed values already include the profits generated out of the by-products of coconut processing.
- Coconut-based enterprises involving value-addition and which have favorable markets are profitable, and there are many possibilities for improving farmers' income.

POLICY RECOMMENDATION

- The concept of value addition is desirable in pursuing the goal of increased farmer income.
- However, additional capital outlay may be necessary which makes the concept unattractive to small farmers.
- Nevertheless, increased awareness through information campaigns which promote the economic benefits of biomass products may be conducted.
- It must be stressed that, in the long run, such economic benefits may offset the costs entailed by technology adoption.

POLICY RECOMMENDATION

- The Philippine Biofuels Act of 2006 mandates a 1% by volume blend of CME into diesel fuel, for year 1 and 2% biodiesel blend for year 2
- It will trim down country's dependence on imported oil
- The demand for biodiesel is expected to increase which would accelerate biodiesel utilization across the country and exploit indigenous, renewable, and clean energy sources.

POLICY RECOMMENDATION

- Policy measures to address the constraints to the adoption of biomass energy technologies
- and strategies to enhance market competitiveness of the biomass industry
- are therefore necessary to make the biomass and biofuels industry sustainable

Thank you