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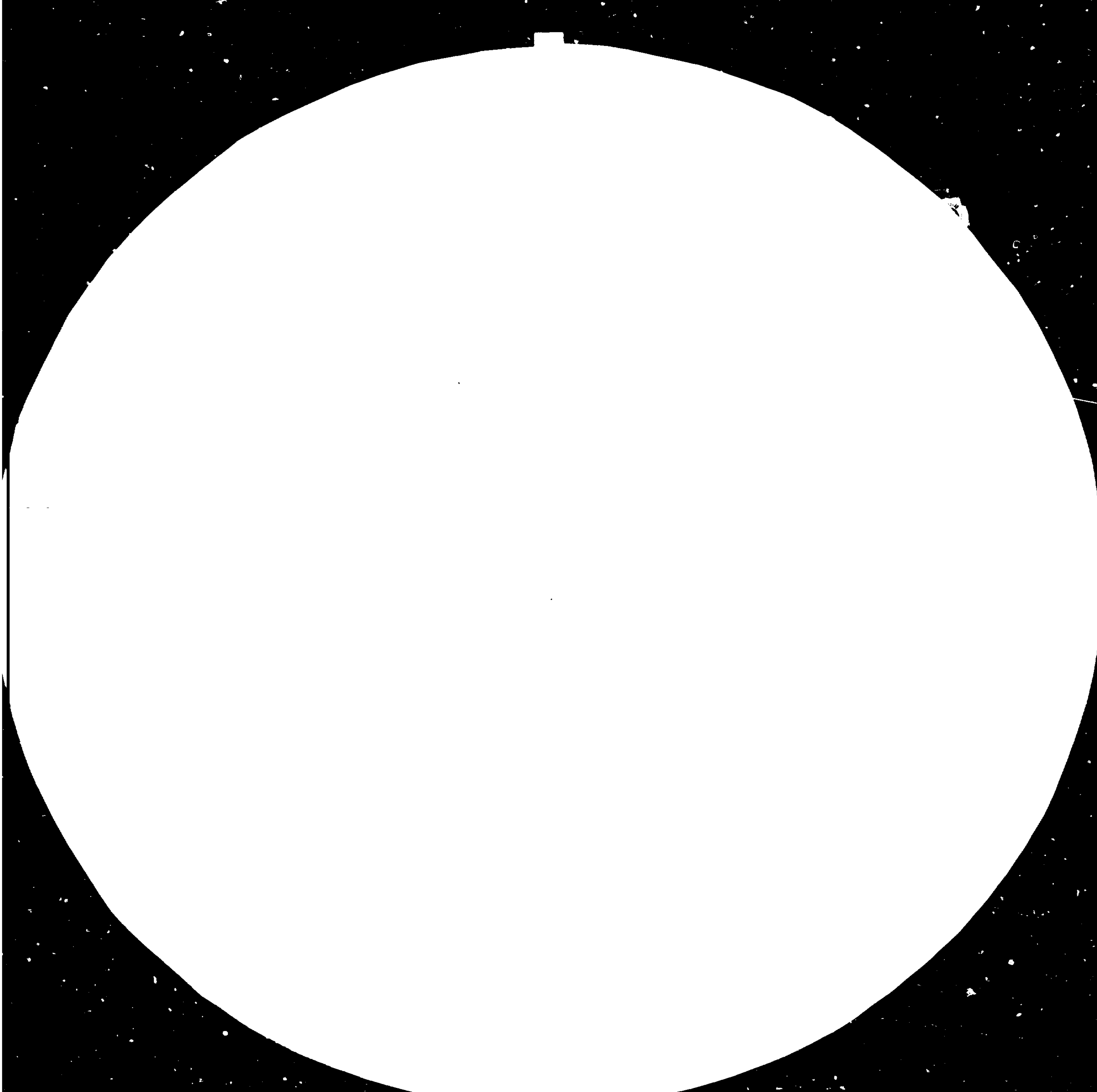

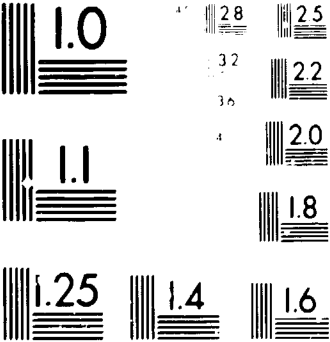

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BIOENERGY FROM FARM WASTES AND/OR BY FARM WASTES FOR RURAL DEVELOPMENT*

by

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The topic of my paper is bioenergy from farm wastes and/or by farm wastes for rural development. By energy from farm wastes, I mean energy sources derived from agricultural waste materials. A good example is biogas. It is a fuel gas which is produced from animal manure. Alcohol, a liquid fuel, is made from molasses, which is a by-product in sugar milling. On the otherhand, some farm wastes may be used to generate other energy sources. Rice hulls may be used to fire a boiler to produce steam. Coconut shells, husks and petioles may serve as fuel to produce crude coconut oil. Wastelands can be utilized for energy plantations.

Let me illustrate these by citing actual experiences in the Philippines; not experiments or pilot operations; but commercial and industrial scale operations which show that bioenergy from farm wastes can be practicable and viable.

BIOGAS FROM MANURE

Biogas is produced by the action of methane producing bacteria on organic materials under anaerobic conditions. Among the organic wastes available in the farm, the animal manure has the best potential for biogas production for rural development.

The biogas plant consists of two main parts: the digester where the raw material is retained to ferment; and the gasholder where the biogas is stored pending use. There are four types of digesters; the continuous-process digester which uses only manure as raw materials; the batch-process digester which uses manure and dry, chopped vegetable matter; the combination batch and continuous process digester which uses manure and green vegetable matter as raw materials; and the supplementary digester which is used to ferment very dilute wastewater.

There are three classes of biogas plants: the household biogas plant which produces biogas for household appliances; the commercial farm biogas plant which provides fuel for farm operations; and the agro-industrial biogas plant which generates the fuel gas for integrated livestock farm and industrial operations.

There are three types of household biogas plants:

- the design commonly used in India has a vertical continuous-process digester with an integrated floating gasholder. It is used in small farms where the water table and flood level are low;
- the biogas plant common in Taiwan has a horizontal, continuous-process digester with integrated floating gasholder. It is used in small farms where the water table and/or flood level are high;
- the type commonly used in mainland China has a combination batch and continuous-process digester with a fixed-dome gasholder. It is used in small farms where the raw materials are manure and green vegetable matter.

A private commercial enterprise in the Philippines is the first to use biogas in a large industrial scale. Maya Farms, the agro-industrial division of Liberty Flour Mills, Inc., actually started its biogas works in 1973 primarily to control pollution. But when the energy crisis came, the biogas was harnessed to provide fuel for its integrated livestock farm and meat processing operation.

The commercial biogas plants designed by Maya Farms are characterized by multi-digesters and separate floating gasholders. Where only manure is used as raw material, the digesters are of the continuous process, double-chambered, horizontal and constructed sided by side in multiple rows. Where manure and dry crop residues are used, the digesters are of the batch-process, single-chambered and constructed in a cluster. The digesters are discharged and recharged sequentially, once a day, to ensure a continuous supply of biogas. Where the manure and green vegetable matter are used, the digester is of the combination batch and continuous-process, three-chambered, horizontal, and built in multiple rows.

The agro-industrial biogas plants use the same design as the commercial biogas plants. However, supplementary digesters are added to process the excess wash-water, thus, increasing biogas production. Since the gas is utilized mostly as fuel for internal combustion engines, it may be desirable to scrub off the carbon dioxide component. Removing the inert CO_2 will increase the horsepower generated by an engine.

As mentioned earlier, the biogas works at Maya Farms have been established primarily to control pollution of the environment. The biogas plants effectively controlled air pollution. But the large volume of sludge from the digesters is still a strong water pollutant. In solving this problem, Maya Farms has gradually evolved a sludge conditioning system. The sludge solids are recovered in settling basins and recycled as feed materials. The liquid filters out through grass cuttings at one end of each basin and passes through the precipitation canals where fine entrained solids are also recovered. From the precipitation canals, the liquid goes through the sludge conditioning lagoons. Exposure of the liquid to sunlight and aeration in the shallow lagoons enhances its value as fertilizer-irrigation water while getting the pollution characteristics within tolerable levels.

The biogas works is the operating combination of the biogas plants and sludge conditioning plants. At Maya Farms, it processes over 75 metric tons of manure coming daily from 50,000 pigs, Aside from controlling both air and water pollution, it produces fee fertilizer, and 4250 cubic meters of biogas per day.

For household use, biogas serves as fuel for cooking, ironing clothes, lighting and running gas refrigerators. Maya Farms uses it for the industrial cooking and other heating purposes in the meat processing plant. It fires the retorts in the rendering plant.

Biogas is also a good fuel for spark ignition engines. In fact it has a much higher octane rating than premium gasoline. Gasoline engines are easily converted to run on straight biogas. Biogas-fueled engines drive the deepwell pumps, slurry pumps, feedmill machinery, refrigeration systems and electric generators driven by V-8 engines. A 188 Kva Caterpillar generator has a turbo-charged natural gas engine which has been converted to run on biogas.

The meat processing operation requires a lot of energy for cooking, drying and refrigeration. To supplement biogas, Maya Farms uses other indigenous sources of energy. Most of them have played some role as energy sources at some time in the past in the Philippines.

RICE HULL

In the early days the Philippines was completely dependent for mechanical power on steam boilers fired by imported coal. During World War I, coal could not be imported. Wood from the nearby forests was used as substitute fuel. When the nearby forests were exhausted, the rice mills used rice hulls to fire the boilers. Rice hull was also used as fuel for drying palay harvested during the rainy season. The Bigol Farm in Pangasinan found that there was sufficient rice hull to supply the fuel required to run the rice mill and the palay dryer.

At Maya Farms, rice hull is used in the duck breeding house. After the rice hull gets dirty, it is burned to supplement biogas in heating the drying room in the rendering plant.

ENERGY PLANTATION ON WASTELANDS

When the Japanese occupation army took over the supply of petroleum products during World War II, the Industrial Products of the Philippines, Inc., developed the IPOPI light charcoal-fed gas producers. These were installed in vehicles to provide producer gas to run the engines. The charcoal-fed trucks transported food from the farms to the centers of popopulation.

At Maya Farms, about ten hectares of wastelands have been planted with the giant variety of ipil-ipil trees (leucaena leucocephala). The leaves serve as animal feed. The branches and twigs are used as firewood. The trunks are made into charcoal which are used as fuel for the gas producers. Producer gas runs the engines which drive water pumps and electric generators.

STRAIGHT HYDROUS ALCOHOL AS SUBSTITUTE FOR GASOLINE

During the 1920's research conducted by the La Carlota Sugarcane Experiment Station of the Bureau of Plant Industry, in cooperation with the Department of Agricultural Engineering of the University of the Philippines at Los Baños, developed the technology to use straight hydrous alcohol as fuel for gasoline engines. The sugar mills manufactured the alcohol from molasses using bagasse as fuel. The sugar planters mechanized their operations using the low cost alcohol to run their trucks and tractors. The bus companies followed suit.

Maya Farms utilizes the waste heat in the exhaust gas from the biogas-fueled engines to produce alcohol from either cassava or molasses. The straight hydrous alcohol is used as a substitute for gasoline.

STRAIGHT CRUDE COCONUT OIL AS SUBSTITUTE FOR DIESEL FUEL

To run the diesel engines during the war, crude coconut oil was used as fuel. The oil performed very well as long as it was preheated to reduce the viscosity prior to injection into the combustion chamber. This was accomplished by adding an extra length of piping to the fuel line and coiling this around the hot exhaust pipe.

Maya Farms has a coco-fed jeep and a coco-fed delivery van. Although coconut oil in the urban areas still costs a little higher than diesel fuel, we have these coco-fed vehicles to work on further refinements so that when the cost of diesel fuel catches up with coconut oil, or in case of fuel shortage, we would be ready to convert the other delivery trucks to coco oil.

When the Governor of Capiz visited Maya Farms, he got enthusiastic about the use of coco oil. He requested for transfer of technology to his province. Now he has seven dump trucks, one grader and one bulldozer fueled by straight crude coconut oil. To get low cost oil and provide work for his constituents, he organized one barangay in his province to produce the coconut oil. The oil was extracted using the ancient method - manually grating the coconut, pressing the grated coconut meat, and boiling the coconut milk to separate the oil. It worked, but oil recovery was low and the small barangay had a hard time trying to produce all the oil needed by the dump trucks.

The governor broached his problem to Maya Farms. Research developed a simple self-powered coconut oil mill. The operation involved shredding the coconut with mechanical graters, drying the grated meat, pressing in an oil expeller and filtering the oil. The coconut husks were used as fuel for drying. The shells were made into charcoal and used in a gas producer which run a converted gasoline engine to provide the power for the whole operation. A barangay in Capiz is now using the first self-powered coconut oil mill.

CONCLUSION

The Philippine experience shows that bioenergy is practicable. The next question is economics. Does it pay?

Let us consider biogas. APPENDIX I shows a study pm a 100 sow-unit and a 500 sow-unit piggery operation. On the bottom line it shows an ROI of 25.2% for the 100 sow-unit and a higher ROI of 47.2% for the 500-sow-unit. The cost analysis, however, indicates that the interest expense constitutes a high percentage of the operating cost. Hence the economic viability of the biogas operation depends to a large extent on the cost of the biogas installation. The biogas operation would be viable as long as a simple low cost design is used.

In case of the coco oil, APPENDIX II shows the break-even calculations for the coco oil and nuts. The major costs consideration in the economic viability of the coco oil is the cost of the nut. The coco oil mill is designed to be set up and operated right under the coconut trees in areas where the cost of coconuts is minimal.

These cases show that bioenergy is best suited for production and utilization in the rural areas. It is fortunate because it would create more opportunities for gainful employment. The availability of reliable sources of energy would stimulate more economic activity. It would raise the quality of life in the countryside. The technology is most appropriate for rural development.

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APPENDIX I

B I O G A S W O R K S

	100	500
Piggery size, in sow units	100	500
Biogas Production, cu.m./yr	30,600	153,000
Biogas equivalent in power generated, KWH/Yr.	45,900	229,500
Sludge Recoverable as Feed Material (dry basis) Kg/yr.	54,000	270,000
Cost of Biogas Works	₱ 180,000	₱ 700,000
Operating Expenses -		
Laborers	₱ 15,000	₱ 45,000
Depreciation, 10%	18,000	70,000
Maintenance, 2%	3,600	14,000
Interest, 25%	45,000	175,000
Total, Operating Expenses	₱ 81,600	₱ 304,000
Net Savings*		
Savings on Power Cost, ₱1.00/kWH	₱ 45,900	₱ 229,500
Savings on Feed Cost, ₱1.50/kg.	81,000	405,000
Total Savings,	₱ 126,900	₱ 634,500
Less Operating Expenses	81,600	304,000
Net Savings	₱ 45,300	₱ 300,500
Return on Investment-------------------	25.2%	47.2%

* excluding possible savings on pollution control and fertilizer.

APPENDIX II

FARM COCO OIL MILL

No. of Workshifts	1	2
Cost of Equipment & Machinery	₱ 86,000	₱ 86,000
Expelling capacity, kg/hr	20	20
Productive worktime, hr/day	7	14
Oil Output, kg/yr (300 days)	42,000	84,000
Nuts required per year (oil x 7)	294,000	588,000
Coco meat output, kg/yr	28,000	56,000
Crude coco oil price per kg (equivalent to diesel price of ₱4.43)	4.03	4.03
Coco meal price per kg	1.80	1.80
Sales Revenues:		
Coco Oil	₱ 169,260	₱ 338,520
Coco meal	50,400	100,800
	₱ 219,660	₱ 439,320
Expenses -		
Labor	₱ 34,500	₱ 69,000
Depreciation	9,450	12,200
Maintenance	7,400	9,900
Sales Tax, 2%	43,900	87,800
Interest	16,400	16,400
Miscellaneous	7,000	7,000
	₱ 118,650	₱ 202,300
Income before nuts	₱ 101,010	₱ 237,020
Break-even Value per Nut	₱ 0.3436	₱ 0.4031