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EVALUATION OF THE PERFORMANCE OF THE TEXAS A&M RESEARCH FOUNDATION IN FULFILLING THE CONDITIONS OF CONTRACT AID/EA-C-1073 IN THE PHILIPPINES

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TABLE OF CONTENTS

		Page
I.	Recommendations	1
II.	Summary and Conclusions	1
III.	Background	3
IV.	Instructions to the Task Force	5
V.	Process Economics	6
	A. Summary and Conclusions	6
	B. Raw Materials Supply	8
	C. Process Material Balances and Yield	9
	D. Pilot Plant Studies	10
	E. Quality Control	12
	F. Storage and Packaging	13
	G. Investment and Operating Costs	13
	H. Economics of Alternation Processes	14
	I. Economics of Aqueous Process	15
VI.	Marketing	35
	A. Summary and Conclusions	36
	B. Recommendations	36
	C. Problems	37
	D. Opportunities	39
	E. Retail Stores Survey	43
	F. Processor Costs	45
	G. Ingredient Prices	46
	H. Consumer Data	47
	I. Demographics	48
	J. Utilization of Flour	51
	K. Inflation Rates	52
	L. Margins	53

TABLE OF CONTENTS

		Page
VII.	General Considerations	56
VIII.	Acknowledgements	58

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MAY 31, 1977

I. Recommendations

A. It is recommended that the Aqueous Process Pilot Plant operated under the supervision of the Texas A&M Research Foundation at San Carlos University in Cebu City, Philippines, be operated to produce the most appropriate products and that these products be provided to interested organizations, government or private sector, in sufficient volume to accomplish adequate market testing and evaluation.

B. Special assistance by marketing and product application specialists should be provided for those companies planning test marketing and further product tests. Such assistance would not only be valuable for future projects, but encourage prompt execution of testing and focus on problems/opportunities encountered for prompt correction or exploitation.

C. It is recommended that the higher protein, lower fiber products produced by the aqueous process, be compared with food grade copra and coconut flour identifying possible or probable uses, possible markets and market demands, and costs of producing the products.

D. It is recommended that this project be continued to produce market test product and assist in the application for potential users. Any or all further work that might be contemplated on coconut flours, food grade copra, or higher protein, lower fiber products and processes should be the subject of separate contracts.

E. It is recommended that the more detailed studies described in Section 2 be made of process and scale-up design before considering the construction of a commercial scale plant, after completion of the market evaluation.

F. The Task Force recommends that the use of coconut flour, copra, and higher protein-lower fiber products from coconuts be given serious consideration for inclusion in the internal food supply of the Philippines.

II. Summary and Conclusions

A. The Texas A&M Research Foundation has fulfilled the specifications set forth in the contract with the exception of Number A7 (Part), and A10. Performance with respect to work with industry to develop product applications was accomplished while evaluation of potential markets is incomplete. Through mutual agreement of the interested groups, the work on food grade copra (A10) was postponed for potential future study, preferably by the Philippine Coconut Authority.

B. The aqueous process for the extraction of a higher protein fraction from the coconut is an operable and satisfactory process. The oil as a by-product is a high quality oil and demands some premium on the present market. The eight products produced, four of which are dried and four of which are in the syrup form, all have potential but their real commercial use must be determined by market evaluations.

C. While the economics of the process and the capital costs required must be further evaluated, it appears from the figures presented that the costs are within the limits of economic possibility, but appear to be marginal from a private sector viewpoint.

D. The pilot plant should be operated through the remainder of the contract period to produce sufficient products to get a more complete market evaluation.

E. The Philippine government, as exemplified by the Secretary of Agriculture, the Director of the Philippine Coconut Authority, the Director of the Nutrition Center of the Philippines, and the Director of the Food and Nutrition Research Center, has given this project both moral and financial support and has shown a real interest in continuing this type of work.

F. This project is an excellent example of the implementation of the policies of our government in transferring appropriate technology to countries which desire such information, particularly in the food production area. The Philippine AID Mission, the Texas A&M Research Foundation, and the Philippine Government are to be commended for undertaking and following this project to a successful conclusion.

G. Dr. Hagenmaier has fulfilled his assignment in admirable fashion in putting together a staff which can operate the plant successfully, in training the individuals, and also in presenting most of the information during the three-day conference. The material prepared for that conference is very complete and concise and it certainly is comprehensive. Dr. Hagenmaier is to be commended for his efforts and his accomplishments.

H. Technicians have been trained to operate the pilot plant on a routine basis, but technical supervision must be supplied if further research is to be accomplished in the pilot plant.

I. One area of criticism of the project would be that the work could have been expedited and focused much more sharply if the products to be produced had been positioned in the market and in the specific food products to be marketed before the pilot plant operation was started. This would have permitted a sharper focus and a clearer definition of the products which might be desired on the Philippine market. This deficiency, even after two years of operation, appears to be the major shortcoming in the results obtained.

J. The aqueous process has a significantly higher capital investment per unit of product than do coconut flour processes. This higher investment must be justified through practical market demand for a low-fiber-high-protein product.

K. Further process engineering studies are needed to evaluate and compare coconut protein and flour processes.

L. At the risk of assuming the role of "two-week experts," this Task Force believes that coconut flour and copra and other food products derived from coconuts, in addition to the oil, can play a very significant role in the food supply and in the general economy of the country, in spite of the questionable economics of the present calculations.

1. The Philippine Republic leads all other countries in the production of coconuts.

2. Coconut products could be used to replace part of the wheat flour produced from imported wheat, thus improving the balance of payments.

3. Coconut products, such as those produced by the aqueous extraction process, could be used to substitute part of the imported dried skim milk, thus improving the balance of payments.

4. Coconut products could be used as a source of good quality protein, helping to improve the nutritional status of some segments of the population.

5. Further refinement of processes and products should result in a more favorable economic outlook for these products. Very few products are ready for immediate commercialization following pilot plant demonstration of a process.

For these reasons, it is the opinion of this Task Force that this type of work is worthy of further support on the part of the Philippine government and industry.

III. Background

An investigative team consisting of three members was requested to go to the Philippines for an on-site inspection of the facilities, the process, the personnel and to evaluate the progress that had been made and the reception the work has received in the host country. The members of this team were Herbert Kraemer, Manager of Engineering Economics, General Mills, Minneapolis, Minnesota; Vaughn Larrison, Marketing Manager, Swift and Company International, Chicago; and H. L. Wilcke, Consultant, Ralston Purina Company, St. Louis, Missouri. The timing of this visit was determined by the fact the three-day symposium was to be held April 25 to April 27 to explain the progress, the conditions under which the process

might be most suitable, the feasibility of the processes developed, and some insights on the probable cost of building a plant and operating the process. This conference had been scheduled by Dr. Robert Hagenmaier, the resident project leader at the site of the pilot plant which was San Carlos University in Cebu City, Cebu, the Philippines. The plan of action called for Kraemer to go to the Philippines one week before the conference was to be held in order to give him time to evaluate the process, to check the calculations on costs of operations, and in general to determine the feasibility and practicability of the process which had been developed. Each of the participants was to spend approximately two weeks, or whatever time required, more or less, in the Philippines to gather the information needed. Larrison and Wilcke were to arrive in time for the conference on April 25-27 and complete their work following the conference. Upon return to the United States each member of the team was to develop his part of the report separately and then the team would meet to iron out the final report and try to complete the report by May 31, 1977.

Research on the basic concept for the isolation of higher protein fractions from the coconut was started at Texas A&M in late 1970 or early 1971. The work was reported to AID under whose grant the work was financed, in part, at least, and quarterly reports which were reviewed by a reviewing committee set up by AID. A final report was submitted following the eight quarterly reports and in March of 1973 a separate team consisting of Herbert Kraemer of General Mills, Francis E. Calvert of Ralston Purina, and Donald Grindstaff of Energy Products, Stauffer Products, Minnesota, visited the Texas A&M facilities, reviewed the work and commented on the feasibility and practicality of the process which had been developed.

After some investigation of possible sites for a pilot plant to develop the process, the Philippines were selected as the most desirable location for such a pilot plant. Equipment had been obtained, resulting in the development of the pilot plant in some facilities which were already available at San Carlos University at Cebu, and work was started in March of 1975. The scope of work which was to be performed by the contractor under contract AID/EA-C-1073 was stated as follows:

A. In the Philippines

1. Complete installation of equipment.

2. Train personnel.

3. Complete shakedown of the pilot plant.

4. Prepare food grade samples of coconut skim milk (dehydrated or concentrated, made with or without coconut water), and other coconut products and by-products.

5. Do process development with goals of maximizing efficiency.

6. Solve processing problems resulting from continuous processing under tropical conditions, which especially concerns microbiological control.

7. Work with industry to develop product applications and evaluate potential markets for the products.

8. Distribute samples and information, especially to local industry in order to promote industrialization of the products.

9. Invite visitors and trainees, and thus serve as a demonstration facility.

10. Serve as site or activity center for large-scale trials to make food grade copra.

11. Write publications and reports.

B. At Texas A&M University

1. Study preparations, processing behavior and properties of food grade copra.

2. Do microbiological, chemical and physical analysis of samples sent from Philippines.

3. Provide technical and administrative assistance to Philippines as needed.

4. Do further pilot plant processing of dried samples sent from the Philippines.

IV. Instructions to the Task Force were as follows:

A. Participate in conference, April 25-27.

B. Critical evaluation of pilot plant operations and feasibility of the process and products.

C. Determination of whether contractor has fulfilled obligations of the contract with USAID (EA-C-1073).

D. Itemize additional work, if any, needed to achieve project goals.

E. Prepare interim evaluation report to be turned over to mission in Philippines prior to departure for USA.

F. Prepare final report for submission to USAID no later than July 31, 1977.

PROCESS ECONOMICS

I. Introduction

The Process Economics Section is concerned with those factors which influence the costs of production. Included are raw material costs, operating costs, and capital costs. Analyses are made indicating areas where high costs may be expected, and where savings might be achieved. The pilot plant work is reviewed.

This report also evaluates whether the contractor has fulfilled the obligations of the contract with USAID (EA-C-1073).

II. Summary and Conclusions - Process Economics

A. The pilot plant has been operated in a consistent manner producing a quality product with a minimum of microbiological contamination.

B. Adequate measurements have been made in the pilot plant of material balances and product yields as are needed in the calculation of process economics.

C. The operation of the Texas A&M aqueous coconut process has been adequately described in an extensive summary report entitled "Coconut Aqueous Processing" by R. Hagenmaier in 1977.

D. Although the process development work has been carried out excellently, very little detail process design work has been done to date, with the intention of optimizing the process and reducing capital and operating costs.

E. Further studies are needed at equipment vendors or in pilot plant areas on scale-up to a commercial size with the goal of maximizing throughput for given capital investment.

F. Approximately 63% of the sales revenue from the proposed commercial plant is high quality natural oil, whereas only 8% of the sales revenue is the target protein product, Cocopro 1. To be economic, the process, therefore, must compete against conventional oil mills. The Texas A&M process has been shown in the pilot plant to have an oil yield within 2% of the commercial oil mill yields, and it is expected that, with further work, the two yields might eventually be comparable. The aqueous process furthermore produces a much higher quality oil than conventionally produced in oil mills, with low color and low fatty acid content.

G. A 6% premium has been offered for the aqueous process oil, which completely compensates for the slightly lower yield experienced in the pilot plant operation.

H. The aqueous process, however, has a high capital investment compared with conventional oil mills. For the same capital investment as the proposed commercial plant, the conventional oil mill might produce approximately four times more product and generate almost four times as much sales revenue. This added capital investment must be justified primarily through production of the protein product.

I. The capital investment shown in the report for the aqueous process is subject to relatively high estimation errors. Detailed process engineering has not yet been carried out, nor has necessary detailed equipment sizing work with all the equipment vendors been done. A ratio analysis of the capital investment numbers indicates that the installation costs may be erroneously low, and that the ultimate cost based upon the present configuration might be as much as twice that quoted. On the other hand, since no extensive capacity studies were made, capital savings might still be achieved without sacrificing production. For the proposed commercial plant, capital investments might be anywhere in the range of U.S. $4.7MM to 11MM.

J. The raw material nuts and the primary crude oil both vary in price widely due to market conditions. The profitability of conventional oil mills as well as the new aqueous process are, therefore, seen to fluctuate widely with time. Some financial risk will be involved in investment in the aqueous process, unless adequate governmental subsidies or guarantees are provided.

K. Various methods can be used to calculate a premium price to be charged for the protein product to provide adequate return on the added investment in the aqueous process. One calculation indicates that a selling price of 2.6 pesos/kg. is needed.

L. Other protein processes have been proposed, including food grade copras, Anderson/IBEC, and the TPI process. Preliminary data indicate that the food grade copra process might produce a product at approximately two-thirds the cost, but containing less protein and a significant amount of fiber. On a protein basis, however, the production cost of food grade copra and the aqueous process appear to be somewhat comparable. Further process engineering studies are needed to evaluate and compare the various processes.

III. Discussion

The Coconut Business

The Philippines is the largest producer of coconuts, accounting for 68% of the world production. Published statistics indicate most of the Philippine coconuts are exported as copra or oil, Table I. Domestic consumption is not thought to be great, averaging only four or five food nuts per capita per year. Additional coconuts are consumed domestically as manufactured

cooking oils. Traditionally the Philippines has exported more low value copra than the high value oils. In order to improve the balance of trade, the government recently enacted a policy encouraging domestic oil production, Table II. Oil mill expansions, primarily in the Mindanao area, will soon be sufficient to process all coconuts grown in the Philippines.

Unfortunately the aqueous coconut process is about seven years too late to participate in this recent growth in oil mill capacity. It is felt, however, that further limited expansions might be possible, and that the aqueous would be a candidate.

Raw Materials Supply

The primary raw material for the process is a husked nut (termed dehusked nut in the Hagenmaier report). Although coconuts are a major crop in the Philippines, the husked nut is not a general article of commerce, at this time. Apart from local private consumption, the only users of a husked nut are the eight desiccated processing plants, Figure 1. The desiccators use only 3% of the total coconut crop and make special arrangements for the purchase of the husked nuts. To be acceptable in either a desiccation process or the new aqueous process, the nuts must be unbroken and of a specific maturity, neither too young nor too old. Problems are, therefore, expected in competing for the necessary quality of coconut, in competition with the desiccated plants who have higher margins in their processes and can bid higher for the material.

In the short term, coconut supplies might be a problem for the aqueous process, but over a sufficiently long period of time it would be expected that market practices might be changed and local areas might be developed to produce the necessary coconuts for commercial operations. The coconut is a major crop in the Philippines, being exceeded only by rice, corn and sugar. Approximately 24% of the arable land is planted in coconuts, with some intercropping of other products in between the trees. Approximately 274 million trees are in the Philippines as shown in Figure 2, with major growth in the Luzon, and Mindanao areas. Typical production of coconuts experienced in the Philippines range from 22 to 50 nuts/tree/year, with tree densities of 120 per hectare. The lower yields are being experienced in the northern areas (Luzon) due to the increasing prevalence of the Cadang-cadang disease. A governmental program has been initiated to replant coconut trees with a new dwarf variety whch requires intensive cultivation practices, but is expected to increase productivity per tree by three-five fold. The government is spending approximately $80 million per year on this program and expects the first product to be available by 1980.

The husked nut needed for the aqueous process has a short shelf life of about one week and is easily damaged in transit. The poor roads in the Philippines make transportation in the rainy season to be difficult, and, therefore, husked nuts will probably come predominately from a local area. Copra is the normal item of commerce and has an extremely long shelf life.

In a discussion with the Franklin Baker desiccating company, it was found that they have developed a group of about twenty brokers who supply their husked nut requirements. At the San Pablo plant for example, they purchase 500 thousand nuts per day. This is twice the amount needed in the target aqueous processing plant. These selected brokers arrange for growers to bring in husked coconuts in trucks ranging from small vans to large ten-ton units containing as much as ten thousand nuts. All nuts are inspected when received and defective nuts returned to the vendor. Payment is based on the net acceptable shipment.

Table III shows some recent price changes in husked nuts. Naturally, as shown by Hagenmaier, the copra and oil prices generally rise and fall in unison. As will be shown later, however, the net margins swing widely because of the extreme leverage in this business.

We have been assured by Perry Quinitio, Franklin Baker. that the prices quoted in the UCAP weekly statistics publication are the ones paid by his company. The prices are based upon delivered and inspected raw material. Apparently no other fees such as broker fees or transportation fees are paid.

A proposed commercial aqueous processing plant requires approximately 250 thousand nuts per day. At an average Philippine production rate of 3,650 nuts/ha/year, approximately seventeen thousand hectares of land is needed (42,000 acres). In the Luzon and Mindanao areas, large coconut plantations currently exist and are in close proximity to each other. Consequently it should be possible to obtain the necessary coconuts in these areas within ten-twenty miles of the plant. In actuality, the seasonal variations require shipments from much further distances at some times. Franklin Baker claims to ship from distances of 300 km during periods of low production. On islands such as Cebu, the coconut trees are not planted as densely and a much larger area of the country must be actively searched in order to purchase the necessary coconuts. At the time of the visit one coconut buyer, one truck and one helper were able to purchase approximately one to two thousand nuts per day.

It is concluded that adequate supplies of husked coconuts, at acceptable prices, may be obtained in the long term, if sufficient effort is made to develop a system of brokers and planters in a 10-100 mile area. Such agricultural programs are currently used for other crops such as guar and should be successful in this case.

IV. Process Material Balances and Yields

Table IV shows the products produced by the aqueous process. It is seen that the target coconut protein product represents only 11% of the total output of the plant. Consequently, the economics of the plant are more determined by the by-product oils and residue press cakes than by the selling price of the

protein. A prior economic study by Texas A&M (Ref. 1) had estimated a higher yield of coconut protein. Table V compares the present and the previous studies, both having approximately the same design throughout.

Somewhat lower coconut protein product is produced in the current process probably because of losses in paring, and because of more accurate pilot plant material balance data.

According to Hagenmaier (p. 6.8) the husked coconut is primarily water. Table VI summarizes the composition of typical nuts. Only 1.7% of the husked nut is protein, and consequently the process economics depend heavily upon by-product sales revenues.

The yields of the two major products, oil and protein, are shown in Table VII. Approximately 57.5% of the protein in the original coconut is recovered in the protein fraction. The remainder of the protein is predominately in the residue press cake. An overall oil yield of 89.2% is obtained based upon the theoretical oil content of a husked coconut. This number is slightly lower than the 93% indicated by Hagenmaier. (Hagenmaier 1977, p. 9.20) Extensive pilot plant yield studies have been made for variations in the process, and for some of the cases presented it is felt that the Hagenmaier data are correct. For the purpose of this economic analysis, however, it was decided to consider only the parch coconut version of the process, and to use only the final numbers presented by Hagenmaier, and reproduced in Table VII. These final numbers were used in the economic calculations but are conservative, and the yields are likely to be improved in the actual practice. Separate data presented by Hagenmaier indicate that the aqueous process currently is 2-3% lower in oil yield than a copra process; however, process improvements to the aqueous process might lead to comparable yields. The higher quality oil obtained by the aqueous process does have a verified 6% market advantage.

In conclusion, from an economic viewpoint, the oil premium of 6% more than adequately compensates for the slightly lower yield of the current aqueous process. The protein yield is relatively low, but if too much protein were removed from the residue the latter may not have adequate markets as feed.

V. Equipment Operation in Pilot Plant and Scale-Up Studies

The pilot plant operation was studied intensively, and the various records reviewed. It can be concluded that the pilot plant studies were accurately performed and that the pilot plant operates exactly in the way as described by Hagenmaier in his recent report. Dr. Hagenmaier is to be commended for his dedicated effort in organizing and training the personnel in the pilot plant, in operating the pilot plant under consistent conditions, and in taking accurate operational data. These data will be valuable for eventual scale-up engineering work.

Ref. 1 Hagenmaier, R.D., et al, JAOCS, 52, 5(1975)

The pilot plant was operated in an integrated manner, starting from raw husked nuts and processing all the way through to finished products. This method of operation thereby assures higher quality operating data and better yield data. Certain comments can be made about the pilot plant operation, which are not intended to be derogatory, but rather to point out opportunities or problem areas in a future commercial plant. Each step of the process will be discussed in order.

The shelling operations were conventional, using manual techniques similar to those practiced by the desiccated coconut companies. Chlorine water was used for sterilization of tools and work services. No work was done significantly on other methods of sterilization, since some activity of this nature had been done at Texas A&M. Furthermore, no work was carried out on automatic methods of shelling coconut, since the Philippine government felt the country was not yet ready for such levels of automation. Over 80% of the personnel of a commercial plant would be operating in the shelling area, and many more jobs would thereby be created with manual shelling.

The grinders were old mild steel units remaining from a prior Krauss-Maffei pilot plant built at the same location in 1961. These grinders were difficult to keep clean, but otherwise functioned adequately.

Two types of expellers were tested, the Brown low pressure units and an old higher pressure Krauss-Maffei unit. The latter again was impossible to clean but in sanitary design might be needed for a commercial plant. The low pressure Brown units were operated in a semi-batch basis, using manual transfer of product in tubs. Runs of several hours only are being made in the pilot plant, and, therefore, no long term biological sanitation experience could be obtained in the expeller area.

The liquid fraction is pasteurized at 65°C, with a tenfold reduction in plate count. This is a low temperature, long residence time pasteurization process, which might not be the best process for this application.

The centrifuge area was operated on approximately a forty-minute batch cycle, because the units were considerably oversized. The centrifuges again had been inherited from the older Krauss-Maffei pilot plant, and had sanitation problems. With the short batch operating mode, it was not possible to return recycle streams in the proper way. Consequently, materials were saved and included in a second pass through the centrifuges. The recycled streams are of some magnitude, and can greatly influence the capacity of a commercial system. More work might be desirable in a future plant in maximizing the throughput of the centrifuge area. For the target commercial plant by Hagenmaier, on the contrary, the centrifuges are twice the required capacity, since smaller ones were not available from the manufacturer. Throughput studies are primarily desired if much larger commercial plants were to be bu

The oil inversion step appears to operate satisfactorily; however, it does contribute to significant recycled streams which are capacity limiting.

The APV evaporator operates satisfactorily without the foaming encountered in some other protein products. A white deposit does build on the heat transfer plates in a seven-hour period, and might cause problems in a commercial plant. The deposits are scrubbed off reasonably easily by the pilot plant persons during the daily cleanup.

An important discovery was made on a method for operation of the spray dryer without excessive product deposits on the walls. It was found that dehumidified air was necessary. This spray drying step is relatively expensive both in capital and operating cost. The drying air enters at 100°C, leaving at 70°C, which provides a very low temperature differential for heat transfer. The spray dryer was a standard four foot laboratory test model using a mechanical spinning atomizer. Even with dehumidified air some deposits did occur on the dryer walls; however, in a larger commercial dryer this problem might not be noticeable. Scale-up studies on the spray dryer could not be made effectively, and further plant tests should be made before specifying a commercial unit.

Further pilot plant operation is expected to be necessary, first to produce more product for market analysis, and second to investigate further the scale-up requirements to a commercial sized plant. It is felt that the major opportunity for a reduction in capital of a commercial plant rests in more precise scale-up and the increase in throughput of the selected equipment.

VI. Quality Control Procedures and Achievements

Despite the use of old equipment which was difficult to sterilize, the pilot plant has been able to produce acceptable quality product both from a chemical and microbiological viewpoint. In Hagenmaier 1977, p. 8.29, the details of the microbiological control methods are described and the lot rejection history given. Out of a total of 215 runs made in the pilot plant, 83 runs were rejected. This is not unexpected in pilot plant operations since many of these runs were for special purposes such as yield measurements and emphasis was not place upon sanitation.

It is concluded that the pilot plant generally demonstrated the feasibility of producing a product with low microbiological contamination.

VII. Storage Tests and Packaging Materials

The products unfortunately are hygroscopic, and must be packaged to prevent absorption of water. It has been found that metal container packaging or a suitable foil is necessary for long term storage. Some product mixtures with materials like rice, on the other hand, do moderate the hygroscopic behavior and might provide adequate storage for certain markets.

The oil is very low in fatty acid and color, if kept dry. It has been found that storage of at least three months is possible without stabilizers or an oxygen-free atmosphere.

The syrup can be stored in polyethylene bags, because it is approximately at an equilibrium water content. Storage of four months is possible without mold growth or significant color degradation if sorbic acid and sodium sulfite are added.

The protein products can also be stored well in combination with sugar, similar to sweet and condensed milk. A sugarless mild product, however, cannot be made since the protein does not stand autoclaving. A significant cost for a consumer product may be the hermetic package required by this material.

VIII. Capital Investment and Operating Cost

The capital investment is shown in Table VIII. The Hagenmaier report has done a good job of describing the capital costs and specifications for the major pieces of equipment. However, the other costs related to a plant including installation, land, buildings, electrical, piping, etc. are felt to be marginally low. As shown in Table VIII, the well known component ratio analysis method described in many texts, including Peters and Timmerhaus, would indicate significantly higher installation costs. The Hagenmaier report makes certain assumptions about the organization, staffing, and contractual arrangements which would be utilized in building a commercial plant. He has also made certain assumptions about electrical and piping requirements which appear quite low compared to present commercial experience with similar plants.

It should be remembered that this capital cost estimate is only a "preliminary feasibility estimate," despite the large amount of detail on specific equipment items provided in the Hagenmaier report. Major uncertainties in the capital investment are not in the equipment, which has been so completely detailed, but rather in all the other aspects and components of a plant which typically are three to five fold greater in cost than the basic equipment. It is futile at this point to argue whether or not the Hagenmaier estimate is correct; rather one should be forewarned that after completion of detailed engineering the ultimate plant cost might be significantly higher. Indeed, another estimating method might indicate a potential capital cost as high as $11 million. This uncertainity in capital cost should be considered, when viewing the economics of the process.

The operating costs used in the Hagenmaier report are shown in Table IX. Again, some of these costs are thought to be slightly low because they do not include the miscellaneous items which in a typical plant would make up a large part of the total cost. For example, the electrical power is based only on the identified equipment items and does not fully provide for all the site uses of electricity. Likewise, depreciation is based only on equipment, FOB, and does not include any depreciation on installation of the equipment. As indicated in the marketing section, the packaging costs are probably low, and the general sales and distribution costs are not included. The protein products are priced FOB plant. It is expected that the plant operating expenses might be somewhat higher than shown in the Hagenmaier report. For the purposes of the present economic analysis, however, the Hagenmaier data are used directly, since the operating cost at the plant is a small part of the total cost. The primary economic emphasis should be placed on the high leverage effects of changes in raw material and product prices.

In conclusion, the Hagenmaier capital investment and operating cost estimates are potentially low. Although the specific data presented are probably quite acceptable, many contingencies, general overheads, administrative costs, marketing costs, sales costs, distribution costs, engineering costs, etc. are usually incurred in commercial processes and are not shown in the Hagenmaier report. These general overhead costs might conceivably be avoided with proper organization of the project, and proper ownership arrangements.

IX. Plant Location Economics

It is concluded that the primary economic factor in plant location is the availability of the coconut raw material. The Hagenmaier report has done an excellent job in reviewing potential plant sites, and demonstrating the basic feasibility of obtaining adequate coconut raw material.

Other economic considerations in plant location are the availability of energy, including electricity and fuel oil, pure water, the proximity to a port of loading and the availability of some 600 employees. It appears that the Mindanao and the Leyte locations are acceptable.

X. Economics of Alternative Processes

The pilot study has not reviewed significantly any of the competing processes for the production of coconut protein. It is considered by Hagenmaier as a matter of judgment that all oil-based processes, such as Anderson/IBEC, and the Philoil processes have never been shown to be workable.

Processing food grade copra has more technical and economic attractiveness. Unpublished industry data have been obtained on a 1976 estimate for a food grade copra plant and is shown in Table X. It is seen that capital costs are less, the protein selling price is less, and more total protein product can be produced for the same investment. A disadvantage of copra product is its fiber content, and, therefore, its presumable use in liquid-type products.

The illustrative economics in Table X should not be taken as definitive but merely implying that a food grade copra product might be more economic if the product is acceptable to the marketplace. The economic exercise of Table X also clearly indicates that the added cost of the aqueous protein product must be supported by perceived superior functional characteristics. As described more fully in the marketing section, the aqueous process protein product ideally should be competing with NFDM, with soy concentrate, or with frozen meat.

XI. Economics of Aqueous Process

As demonstrated in Tables IV and IX, the primary cash revenues and the primary costs involve coconuts, oil products, and press cake residues. The revenues from the protein product in comparison are very minor. The economics of the process, therefore, are highly dependent upon market prices for coconuts, oil and meal and are in direct competition with conventional oil mills. As will be shown later, sufficient revenues can be generated under any reasonable set of assumptions from protein products to adequately cover all contingent costs in the aqueous process. The aqueous plant must instead be designed very economically if the process is to be competitive.

Unfortunately we do not have any economic data on the major competition, namely the conventional oil mills. This information appears to be proprietary, but might be available to certain Philippine government agencies. It is, therefore, not possible in this report to properly compare the aqueous process with conventional oil mills. Rather, preliminary pro forma calculations are presented which are indicative of the economics. Table XI presents the gross margin experienced by the conventional oil mills over the last ten years, based upon published prices for copra, oil, and meal. This table provides an upper limit on the expected profitability of an oil mill. Very large changes in copra and oil prices are seen, whereas lesser changes in gross margin are shown. Except for the latest year, 1977, the most probable gross margin is about ₱0.4/kg. of copra processed by the conventional oil mill. The gross margin includes all plant operating costs including depreciation and distribution, as well as profit.

Hagenmaier has obtained verbal information on capital costs of a conventional oil mill. In Table XII is shown a comparison of the conventional oil mill of approximately 250 tons/day of copra capacity with the Texas A&M aqueous process. Although the

capital costs are identical, the oil mill has about 3-1/2 times as much throughput on a weight basis. Likewise, the revenue generated by oil and conventional by-products is more than 3-1/2 times as great in the oil mill. The gross margins, i.e. the difference between revenue and raw materials, is, therefore, correspondingly greater in the conventional oil milling.

For the purposes of a preliminary economic study, it has been decided to use a pretax R.O.I. basis of analysis. It is our understanding that money in the Philippines demands an interest rate of approximately 16-18%. Additonal returns on capital are required for entrepreneurial risk. Other analysis methods, such as Discount Cash Flow or Present Value, could be used but tend to confuse the basic issues of this study. More elaborate analysis can be made at a later date.

A 25% pretax R.O.I. was selected as a minimum requirement for a plant in the Philippines. This return is in additon to an allowance for depreciation; the depreciation charge reflected in the plant operating expense in Table XII is very minor and is the value given by Hagenmaier in Table 17.2.

In Table XII, the plant operating expenses for a conventional oil mill are not known. However, it is assumed that oil mills are not achieving much more profitability than the 25% minimum, and, therefore, all other unaccounted for gross margin must be plant operating expense. The net revenue is thus zero. The net revenue attributed to protein in the aqueous protein process is a minus $718,000/year. The protein sale must generate this revenue. Consequently, the unit selling price of protein is $355/m ton, or ₱2.64/kg.

Table XII indicates that the minimum selling price for a protein product produced by the aqueous process is ₱2.64/kg. Under this condition, the aqueous process is directly competitive with a conventional oil mill. If the unique functional characteristics of the protein product would permit a higher selling price, then the aqueous process would have an economic advantage.

The above analysis assumes average prices for raw material and oil. In actuality, as shown by Hagenmaier, oil and coconut prices change radically over a period of time as he has shown in his chapter 17, p. 12. The effects of historical variations in prices on the pretax net earnings of the aqueous process is shown in Table XIII. Recently, husked nuts have been selling for 17% of the oil prices, and it is seen that the aqueous process at this time is unprofitable under all reasonable oil selling prices. In prior years, the husked nuts could be purchased for a lesser fraction, down as low as 11%, and in this circumstance the profitability of the aqueous process is quite good.

The aqueous process for producing protein is highly leveraged by the great market swings of oil and nut prices. Profits or losses of 1-2 million dollars per year are to be expected

over a period of time merely due to market price changes in the conventional products and raw materials, completely independently of any marketing considerations related to the protein product.

A businessman, therefore, if interested in producing a protein product, would be relatively cautious about the high exposure to risk he would encounter with this aqueous process. It is apparent that the businessman must reduce the risk impact through some market mechanism or governmental regulation, which would guarantee a moderate but consistent profitability. Alternately, the aqueous process can be included with a larger business enterprise involving selling and buying of coconuts and oil. In the latter case the risk of this particular process would be no greater than the remainder of the business and the businessman would view both equally. Now, the businessman considers the comparison of the aqueous process with conventional oil milling much more precisely; indeed we do not have the necessary data for a correct analysis from this businessman's viewpoint. Hagenmaier was well aware of this economic issue, and felt that if he could properly present his data to the appropriate businessmen, then they could make up their minds on the relative merits of the aqueous process.

Sensitivity analyses can be made so that the outsider can more appropriately determine the variation in risk and costs to be anticipated. Hagenmaier has published a sensitivity analysis (JAOCS, 52, 5, 1975). Table XIV presents a simplified version of a sensitivity analysis, comparing a base case with a worse case. If capital investment is significantly higher, if raw materials are at the highest recent price, and if plant operating costs are 50% higher than projected, then the study indicates a minimum selling price for protein product of ₱17/kg. This selling price is considerably higher than frozen meat and is in the order of magnitude of specialty medicinals, albumens, etc. Current market studies have not indicated the market for such products.

Alternately, if a minor increase in protein selling price can be achieved, say to ₱5/kg., then one sees an improvement in net pretax revenue of about 700 thousand dollars per year. This increase in revenue is still not sufficient to guard completely against risks previously mentioned due to wide swings in prices of oil and coconuts. Detailed risk analysis, in principle, can be made considering the historical record of raw material and product price variations. Such techniques might provide more accurate estimates of the statistical range in prices permitting an acceptable R.O.I. For the purposes of this report, such analyses are not considered necessary. Rather, it is suggested that the above mentioned uncertainties and omissions might increase the net cost of the protein product to ₱5/kg.

In conclusion, the aqueous process may eventually be economically competitive with the conventional oil mill process, when the protein product can be sold FOB plant for a price in the

range of ₱2.64-5/kg. The present lack of broad market in husked nuts will make the aqueous process slightly more risky from a raw material supply viewpoint than a conventional oil mill process. Further risk elements involve unresolved technical problems with commercial scale-up, and political and sociological problems involved in finding market outlets for the product. Further risks occur to a new enterprise not currently in the conventional oil mill process, since the oil mill profitability is not well known. It is highly conceivable that conventional oil mills could lower oil prices further, in relationship to coconut prices and place an economic squeeze on the aqueous process. To remain solvent, therefore, the businessman who has invested in the aqueous process might need to sell the protein product at a considerable increase in price, if permitted by the market, or seek some form of subsidy or price control of raw materials and oil. Governmental policies could be developed to protect this businessman.

TABLE I

END USE OF COCONUT PRODUCTS
(000 m ton/yr)

	EXPORT			DOMESTIC			
YEAR	COPRA	OIL*	DESICC.	MFG. OIL*	HOME OIL*	FOOD NUTS	TOTAL
1965	859	389	89	217	15	24	1593
1975	833	954	80	284	22	44	2217
1976	853	1330	80	300E	22E	44E	2629

* Copra Equivalent

Ref: UCAP 1975 Statistical Yearbook and PCA

TABLE II

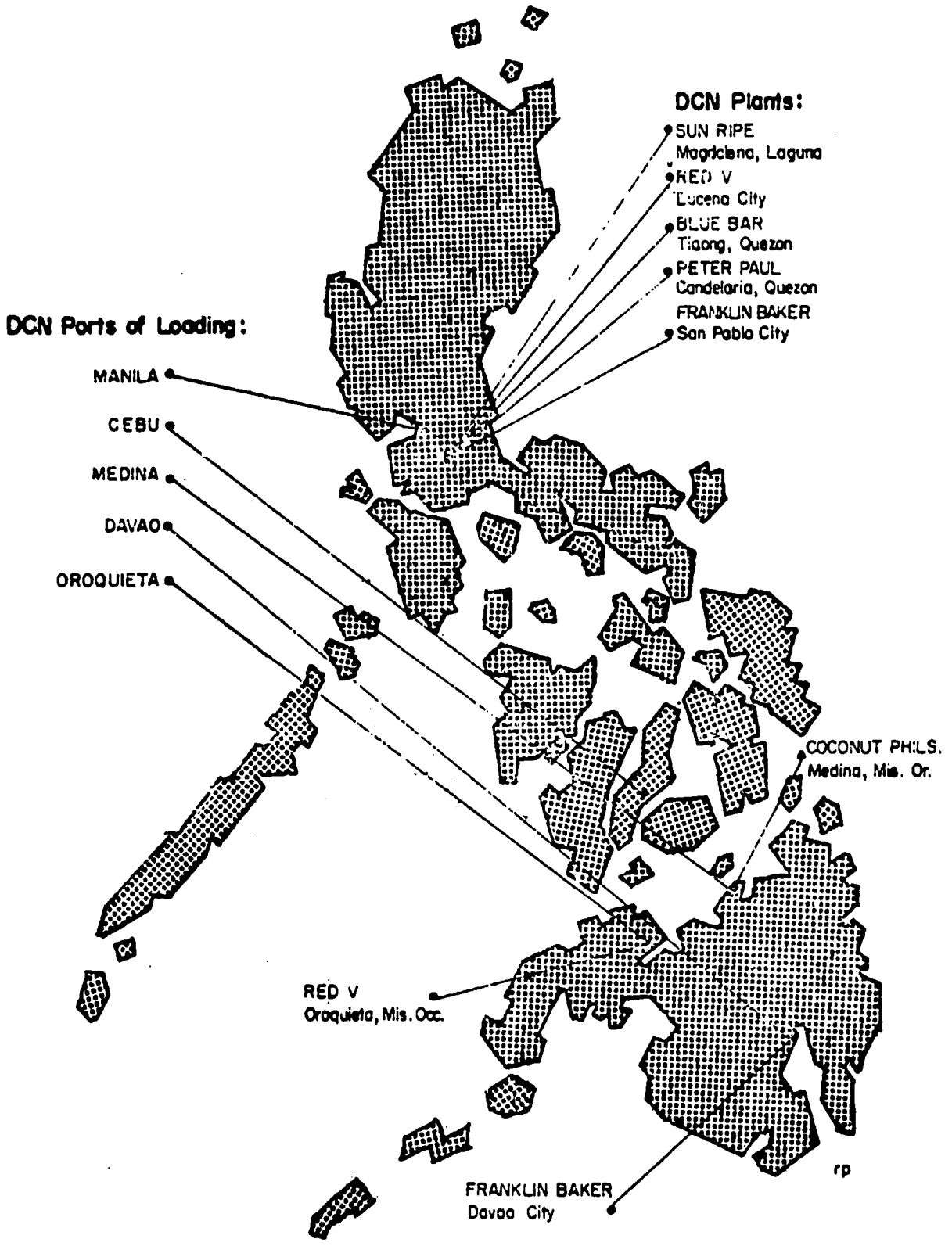
PROPOSED OIL MILL EXPANSIONS
(000 m ton/yr Copra basis)

REGION	EXISTING JULY 1976	PROPOSED APRIL 1977	TOTAL
Mindanao	729.0	1020.0	1749.0
Visayas	269.1	317.5	586.6
Manila/Laguna/Bicol	943.2	200.0	1143.2
TOTAL	1941.3	1537.5	3478.8

Ref: UCAP 1975 Statistical Yearbook, p. 215
Bulletin Today, April 12, 1977

FIGURE 1

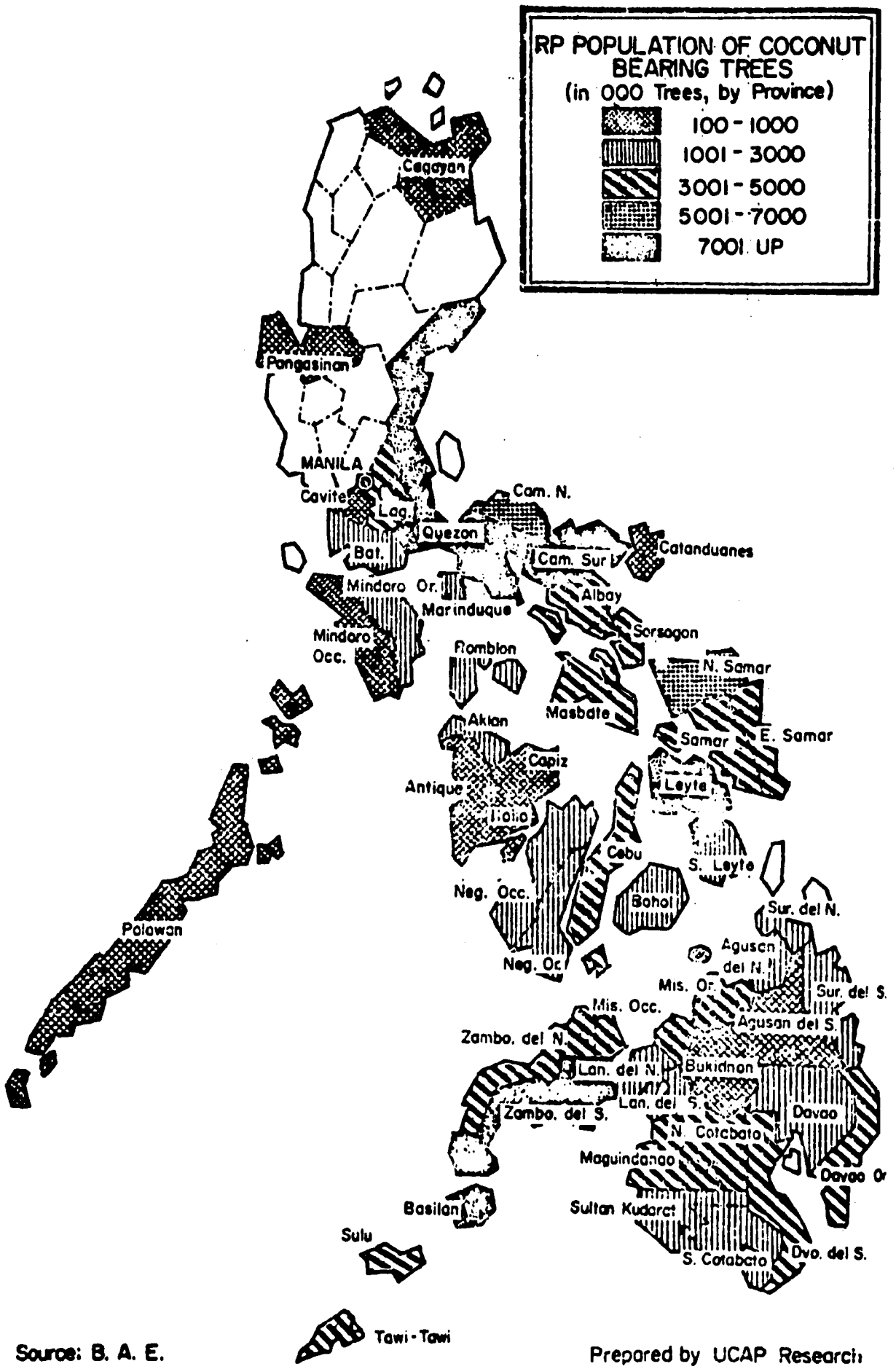
GEOGRAPHICAL LOCATION OF DESICCATED COCONUT PLANTS & PORTS OF LOADING



Prepared by: UCAP Research, JULY / 1976

FIGURE 2

22



Source: B. A. E.

Prepared by UCAP Research

TABLE III

RECENT PRICES OF HUSKED NUTS (UCAP)

	₱/m ton	¢/lb
2/19/76	240	1.46
3/18/76	245	1.49
5/20/76	263	1.60
8/26/76	425	2.59
10/28/76	485	2.96
12/9/76	600	3.66
1/13/77	640	3.90
2/10/77	660	4.03
3/17/77	735	4.48
3/31/77	840	5.13

TABLE IV

ANNUAL PRODUCTION OF COMMERCIAL PLANT
(Pared Coconuts)

Product	Nominal Net Sales Revenue		
	m ton/yr	Peso (000)	U.S. $ (000)
Natural Oil	7,100	29,502	3,960
Cocopro I	2,025	3,809	511
Crude Oils	2,350	9,212	1,237
Press Cakes (residue)	3,450	1,869	251
Charcoal	3,100	2,350	315
Subtotal, By-Products	8,900	13,431	1,803
TOTAL	18,025	46,742	6,274

Ref: Hagenmaier 1977, Ch. 17, p. 2-5
₱ 7.45 = U.S. $

TABLE V

COMPARISON OF PRODUCT YIELDS - 1977 STUDY VS. 1974 STUDY
(m ton/yr, Pared Nuts)

	1977	1974
Natural Oil	7,100	-
Crude Oils	2,350	-
Total Oils	(9,450)	(8,700)
Residue (dry)	3,450	2,690
Coconut Protein (dry)*	2,025	3,106
Husked Coconuts Processed	66,750	62,500

Ref: 1977 Study: Hagenmaier 1977, Ch. 17, p. 2
1974 Study: JAOCS, 52, 5 (1975)

* 34% protein content

TABLE VI

TYPICAL COMPOSITION OF ONE HUSKED NUT

	Weight	%
Shell	265 g	24.3
Coconut Water	345	31.7
Water in Meats	226	20.7
Oil	173	15.9
Carbohydrate in Meats	62	5.7
Protein (100%) in Meats	19	1.7
TOTAL	1090	100

Ref: Hagenmaier 1977, Ch. 6, p. 8

TABLE VII

CALCULATED YIELDS OF MAJOR PRODUCTS

	Theory m ton/yr	Actual* m ton/yr	% Yield
Oil	10,594	9,450	89.2
Protein (100% basis)**	1,164	669	57.5

* Hagenmaier 1977, Ch. 17, p. 2

** Based on 2025 m ton/yr protein product at 34% protein content.

TABLE VIII

ESTIMATED CAPITAL INVESTMENT

	Peso (000)	U.S. $ (000) Per R.H.	U.S. $ (000) Conventional*	%
Fixed Capital				
Process Equipment, Del.	16,900	2,268	2,268	100%
Land, Buildings, Site	5,300	711	2,268	100
Electrical Materials	700	94	227	10
Piping Materials	350	47	998	44
Installation Labor	3,400	456	884	39
Other Equipment	1,150	154	-	-
Engineering & Supr.			726	32
Construction Exp.			771	34
Contractor's Fee			408	18
Contingency			816	36
Total, say	28,000	3,758	9,366	413%
Working Capital (one month)	7,000	940	1,678	74%
Grand Total	35,000	4,698	11,044	487%

Ref: Hagenmaier 1977, Ch. 14, p. 8
₱ 7.45 = U.S. $

* Peters and Timmerhaus, p. 118. Nominal percentages for other projects indicate a total project cost of U.S. $ 11,044 M.

TABLE IX
NOMINAL OPERATING COSTS OF COMMERCIAL PLANT
(Pared Coconuts)

ITEM	ANNUAL INCOME OR EXPENSE	
	PESO (000)	U. S. $ (000)
Net Sales Revenue	46,742	6,274
Husked Coconuts	32,040	4,300
Plant Expenses		
Labor	3,960	532
Overhead	3,628	487
Total Production Cost	(39,628)	(5,319)
Pre-Tax Earnings	7,114	955

Ref: Hagenmaier 1977, Ch. 17, p. 2-5

TABLE X

PROFORMA COMPARISON OF FOOD-GRADE COPRA AND AQUEOUS PROCESSES

	Copra	Aqueous (pared)
Plant size, Copra basis, m ton/day	100	67.5
Fixed Capital, $M	2,550	3,760
Working Capital, $M	1,927	887
Total, $M	4,477	4,647
Revenue - Oil and by-products, $M/yr	10,148	5,763
Less - Raw material, $M/yr	10,740	4,300
Plant operating costs, $M/yr	824	1,019
25% pre-tax ROI	1,119	1,162
Net pre-tax revenue required by protein product	(2,535)	(718)
Production of protein product, m ton/yr	10,555	2,025
% Protein	25	34
% Fiber	9	none
Minimum selling price of protein product, $/M ton	240	355
$/M ton	₱ 1.79/kg	₱ 2.64/kg

Assumptions: Commercial crude oil, ₱ 4000/m ton; Husked nuts, ₱ 480/m ton; Food grade copra, ₱ 2667/m ton.

TABLE XI

GROSS MARGINS IN CONVENTIONAL OIL MILLS*

Year	Ave. Price, /kg/₱			Gross Margin /kg (Copra)/₱
	____	Oil	Meal	
1967	0.622	1.084	0.269	0.115
1968	0.748	1.294	0.300	0.124
1969	0.667	1.133	0.279	0.102
1970	0.951	1.679	0.393	0.182
1971	0.877	1.545	0.400	0.178
1972	0.687	1.202	0.458	0.181
1973	1.738	3.058	0.713	0.325
1974	3.635	6.496	0.685	0.482
1975	1.470	2.636	0.803	0.369
1976	1.450	2.630	0.840	0.400
1977	3.740	5.850	1.075	0.114

*Assumes that one kg of copra at 8% moisture produces 0.60 kg oil and 0.32 kg meal.

TABLE XII

PROFORMA COMPARISON OF CONVENTIONAL OIL MILL AND AQUEOUS PROCESS

	A & M Aqueous Process	Conventional Oil Mill
Plant size, husked nut input equiv. m ton/yr.	66,700	250,000*
Total Capital, $M	4,700	4,700
Production		
Oil and by-products, m ton/yr	16,000	58,200
Protein product, m ton/yr.	2,025	-
Revenue - oil and by-products, $M/yr	5,763	22,074
Less - Raw materials	4,300	18,678
Plant operating expenses	1,019	2,234
25% pre-tax ROI	1,162	1,162
Net Revenue attributed to protein, $M/yr	(718)	0
Minimum protein product selling price.	$ 355/m ton	-
	2.64/kg	-

*Equiv. to 63,250 m ton/yr copra.; see Table IV for value of products.

TABLE XIII

ANNUAL PRE-TAX NET EARNINGS (U.S. $ (000)) INFLUENCED BY RAW MATERIAL AND PRODUCT PRICES (AQUEOUS PROCESS)

	Crude Oil Selling Price (¢/lb)			
Husked Nuts (% of Oil)	12 --	24 --	37 --	49 --
11%	710	1,297	1,884	2,470
14%	253	383	512	642
17%	-204	-531	-859	-1,186

Ref: Hagenmaier 1977, Ch. 17, p. 12

TABLE XIV

PROFORMA WORST CASE ANALYSIS OF AQUEOUS PROCESS

Annual Production of Protein Product is 2025 m ton

	Base Case	Worst Case
Total Capital, $M	4,700	11,000
Revenue - Oil and by-products, $M/yr	5,763	5,763
Less - Raw materials	4,300	6,092*
Plant operating costs	1,019	1,529**
25% pre-tax ROI	1,162	2,750
Net pre-tax revenue required for protein product, $M/yr	(718)	(4,608)
Minimum selling price, $/m ton of protein product	355	2,280
	2.64/kg	17.00/kg.

* Assumes husked nuts sell at 0.17 of oil price compared to base assumption of 0.12.

** Assumes 50% increase in plant costs.

MARKETING OF AQUEOUS PROCESS PRODUCTS

I. Summary/Conclusions

Supporting information for the conclusions is grouped by category although multiple references are necessary due to the number of information sources. Optimum pricing and company attitude conclusions are judgments based on the team member observations.

A. Interest by private companies in utilization of the plant's protein products in commercial food products is moderate to low. Private company decisions on purchase has not quantified by company or by total market. Interest in obtaining volume for further product tests is sufficient to warrant continued pilot plant production.

B. The protein products have no unique or proven superior functional characteristics. For the Philippine market, these products must be considered for now a protein additive with considerable limits on usage levels.

C. There is slim evidence of interest by private Philippine firms to construct an aqueous plant. One major company appears to be advancing plans for incorporating at least a modified aqueous process in a larger food and chemical complex. Assessment of exact company intentions in this area cannot be accurately made.

D. The nutritional value for human consumption of the Cocopro protein products produced is good. As a protein product, no limiting detrimental effects are known. While rural attitudes toward coconuts and coconut products are generally negative, such attitudes could be improved through education.

E. The need for new indigenous protein sources is substantial and increasing. While this need cannot be stated as effective demand, protein output from a single aqueous plant should be easily absorbed domestically, price and quality considered.

F. The best noted benchmarks for determining the wholesale market price at which aqueous protein would be purchased in quantity are food grade NFDM and meat by-products or soy concentrate. Recorded values respectively for NFDM and meat are ₱4.49/kg., ₱6.74/kg. landed dock Manila. Soy concentrate is currently being withdrawn from meat formulations as the cost has increased over ₱6.42/kg. landed Manila.

G. The national balance of payments would be improved by the internal use of coconuts as protein flour versus export of copra. Copra generates $0.102 per pound of export income. Comparative time imports resulted in loss of exchange at

the rate of $0.424 per pound for meats, $0.80 per pound for powdered whole milk, $0.13 per pound for enriched wheat flour.

H. Problems of marketing protein products from the aqueous process outweigh opportunities numerically. Notwithstanding, the pure need for more domestically produced food augurs in favor of commercialization of either the aqueous process or a food grade copra process to supply a protein flour. Not enough is known about copra flour processing to assess its value in comparison to the aqueous process.

I. Commercialization of the aqueous process is unlikely without either government encouragement or additional knowledge of the comparative advantages or disadvantages of producing food grade copra flour. The attitude of nearly all companies contacted is negative on investing in an aqueous plant due in part to the financial uncertainty and accompanying risks, plus the relatively large amount of capital required. Attitudes are significantly better with respect to product utilization and would improve further should a supply of finished product be reliably available on a sustained basis.

J. Products produced by the aqueous process other than protein products can be marketed essentially as stated in the pilot plant reports. The report prepared by Dr. Hagenmaier for the April 25-27 conference was exceptionally well documented Pilot plant operations and aqueous process feasibility studies were quite thoroughly executed as was acknowledged by practically all parties interviewed.

K. Ideal pricing of plant protein products from a sales viewpoint will be 20% under that of NFDM. Such a cost to wholesalers/processors should overcome processor resistance which exists toward use of the products. At a cost to processors of more than ₱2.5/kg., incorporation of Cocopro will likely result in consumer products with a retail price beyond reach of low income purchases. From an R.O.I. view, selling prices of ₱5./kg. and higher will be more acceptable but will have small effect on total results.

II. Recommendations

A. The operations of the pilot plant at Cebu should be continued until present serious product and market tests by Philippine companies are completed. Sufficient product should be manufactured to supply such testing.

B. All companies requiring or which have requested product should be contacted promptly to determine quantities required to complete adequate product and market tests.

C. The one company which has shown interest in constructing a coconut protein facil[illegible] should be visited by appropriate representatives of t[illegible] [illegible]ilippine government and of the

U.S. in Manila. Financing avenues should be discussed and to the extent possible, consideration given by USAID to providing or assisting the company in obtaining long term financing in part or in total for the protein portion of the proposed plant.

D. A Process Feasibility Study, plus a financial and marketing analysis for the manufacture and sale of protein flour produced from copra should be carried out in the Philippines. This effort should be accompanied by a careful determination of finished product criteria to be used as the objectives for product and process development. Such product criteria would logically include characteristics such as: low cost, shelf stable, extended storage life at ambient temperatures, 1:1 water absorption ratio, stable in mixes or blends, easily blended/used and unsophisticated packaging requirements.

E. Appropriate parts of the total team report should be made available to Philippine participants of the Cebu Conference. This will facilitate future cooperation and aid in improving current communication between AID and private companies.

III. Problems

Before any new product can be introduced into the food chain successfully, its strengths and weaknesses must be identified. Further, an analysis must be made to determine where such a new product might be needed and desired in the overall food supply for the population under consideration, what ingredients or products might be substituted or replaced success fully, at what price, and in what volume. The time available in the two areas, Cebu and Manila, afforded an opportunity to gain preliminary information bearing on these questions, and to highlight needs for further information.

The most outstanding problems and opportunities which were apparent to this team were:

A. Cocopro 1 and 3 (Dry Products) - for Philippine market only

1. The products are hydroscopic.
2. The storage life is relatively short.
3. These products have no identified functional advantages.
4. There are some flavor problems (salty, sweet, coconut).
5. Consumer resistance to these products as ingredients was perceived.
6. There is a lack of finished product testing.
7. Color problems, particularly with Cocopro 3.
8. There are quite definite maximum usage limits.
9. The market, for the present at least, is limited to industrial users.

B. Cocopro Syrups (1L or 3L) - for Philippine market only

1. There is a lack of product development in finished products.
2. The viscosity is a problem for some users.
3. There is a color stability problem.
4. There is a fat stability problem.
5. There are maximum substitution/use limitations.
6. In beverages, there is a problem with heat coagulation, flavor, and settling.
7. Packaging must be adequate to prevent mold growth.

C. Cochin oil, charcoal, expeller oils and other products from the process apparently present no problems in marketing as stated in the Hagenmaier report.

D. General Problems

1. Inconclusive functional properties testing.
2. Alternative oil processes potentially require less capital.
3. Low cost grains and NFDM are readily available in these markets.
4. These products blend poorly.
5. The selling price of the protein products exerts a relatively inconsequential effect on R.O.I. because of the low yield of protein product from the process.
6. The necessity of importing process equipment is a disadvantage.
7. There is a wide revenue variation (and risk) from oil caused by commodity price swings.

E. Market Problems Particular to Philippines

1. Low market appeal for protein fortified goods.
2. No refrigerated or controlled storage at the household level.
3. Tinware costs and availability are serious problems.
4. Negative attitude by rural consumers to coconut products was reported.
5. Most rural households do not know how to use flour.
6. Most rural households do not have ovens.
7. New foods are accepted reluctantly.
8. The type of market would result in a slow inventory turnover, estimated to be approximately three months from plant to end user.
9. The coconut oil (copra) interests do not feel the need for these products.
10. Lack of long term low interest financing.
11. Products provided under Title II may be competitive.
12. There are inadequacies in the distribution system, such as roads and capacity of equipment.
13. There is a lack of active interest by most processors.

IV. Opportunities

A. For the private sector -

1. There planned product tests.
2. There is a willingness to test market if products are made available in adequate amounts.
3. The flavor is advantageous in certain foreign markets.
4. Advertising reach and effectiveness could be created.
5. Adequate raw material is available.
6. The product can be made available for tests.

B. On the national basis -

1. These products could provide potential improvement to the national income balance.
2. These products could be useful in helping to alleviate both real and potential protein deficiencies in the diet.
3. A mechanism to force utilization and processor purchase.
4. Interest and awareness by national agencies could be stimulated.
5. These products offer good nutritional quality.

PHILIPPINE COMPANY INTEREST IN AQUEOUS PROCESSING

The following three pages summarize the extent of interest by domestic Philippine companies in either the process or in protein products produced from the process.

Privately, four companies stated plans to utilize varying quantities of protein product from the Cebu pilot plant for product tests. Due to the limits on pilot plant output, product allocation may need to be worked out.

It should be noted from the following summary that only one firm evidenced interest in commercializing the aqueous process.

COMPANY ACTIVITY/INTEREST SUMMARY

COMPANY *	RESPONSE PER PILOT PLANT	RESPONSE PER OTHER SOURCE	CONCLUSIONS 5/18/77
Foreign	No response	Not Checked	-
Domestic	Active interest in intermediate products-not in process.	Currently in test. Product development for export beverage, but want plant to do further work.	Current interest in intermediate product.
Domestic	Initial interest faded; currently inactive.	No test market plans. Further activity depends on economics, i.e. for beverages.	Interest on hold pending availability and cost data
Domestic	Little response.	No interest in process. Would utilize product as animal feed and possibly in snack items if available at NFDM prices.	Potential buyer of product for food grade use - not interested in process.
Foreign	Letter response. Further work possible.	Academic interest only.	No interest.
Foreign	No response.	Palatability and flavor testing completed - flavor base acceptable - no value as protein - no further tests planned.	No interest in product or process.
Foreign	Feb. '77 liked flavor but no real interest.	Decision not involved. Foreign H.Q. neutral due to economics and availability. No active interest now.	No current interest.

COMPANY	RESPONSE PER PILOT PLANT	RESPONSE PER OTHER SOURCE	CONCLUSIONS 5/18/77
Domestic	No interest.	No interest in products or process, per owner. Potentially a user due to type of products marketed.	No interest.
Domestic	Tried in drinks, did not like results. Now trying in ice cream - strong interest in products.	Mild interest. Might use if available.	Possible product user - if product becomes available.
Domestic	Was once interested in products - current status unknown.	Company is interested in flour and a modified process.	Strong interest in modified process.
Foreign	No response.	-	
Foreign	Verbal interest in products.		
Domestic	Wants to purchase pilot plant.	Looking for bargain opportunity-equipment.	No interest for major use or marketing of products.
Domestic	Plans market test June, 1977 - active interest in products.	Pursuing tests with intermediate products for beverages - June '77.	Interest in products.
Foreign	No response.	Treated as novelty item - never evaluated.	No interest.
Domestic	Mild interest in products - no plans to use.	Non-committal.	Unable to determine.

COMPANY	RESPONSE PER PILOT PLANT	RESPONSE PER OTHER SOURCES	CONCLUSIONS 5/18/77
Domestic	No feedback on interest. for processed meats as extender.	Will take 150 kg./wk. marketing.	Interest in test marketing.
Domestic	No response.	No interest in process or products.	No interest.
Foreign	No indication of interest.	-	-
Domestic	Interested in using in drinks.	Interested in further tests over long term.	Interest in products but wants products from P. plant for more market testing.
Domestic	As of Feb. '77 no use for products.	Not able to determine interest level.	Unknown.
Domestic	Unknown.	Company has no use for product or process.	Pineapple/banana packer. No interest.

Note: The above lists are all known companies which have shown at least a minimum of interest in protein products produced at the pilot facility.

* Company identification is not shown due to confidentiality requests. "Domestic" refers to Philippine companies either owned by national or locally operated companies which may be part of a multinational company. "Foreign" refers to company headquarters outside the Philippines where product samples were sent.

RETAIL STORES SURVEY

The purpose of the store visits was to determine pricing, movement by types of foods and regional differences in product availability. With the exception of items such as rice and flour which are price controlled, retail prices in rural markets are 4-20% higher than in metro markets, as might be expected.

Bulk tray displayed grains, powdered drinks and locally grown products have space predominance in rural stores; metropolitan markets have little bulk displayed grains, but a wide assortment of prepared foods. Surprisingly large display space in city markets was devoted to powdered drinks, while small bread and bakery sections were noted.

At the rural level, products at the ₱2 to 3/kg. level received the most space. Mungo beans at ₱5./kg. were considered expensive and not affordable by most consumers.

Prices and items shown in the attached survey are from six food stores in several areas. A more complete pricing survey is available in the background notes done for this study.

STORE A - Small open store at Carcar, Cebu. No refrigerated items; less than twenty linear feet canned goods. Small rural town.

STORE B - Small open store at medium sized town of Toledo City, Cebu. Estimated 150 linear feet shelving for goods. No refrigerated items.

STORE C - Large supermarkets and open market, Manila -- similar selection to U.S. style stores.

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NO. 44

PROCESSOR COSTS

Shown below are three sections of food ingredient costs which will relate to pricing and potential utilization of coconut protein products. The imports' schedule demonstrates the effect of high costing items on volumes.

SECTION I

Agricultural Imports: Philippines

Products	1975 Quantity (Metric Tons)	Price ($) Per lb. Landed	Volume Trend vs. 1974
Meat/Meat Preparations (95% of category represents fresh, frozen and chilled meat)	10,572	.424	2 1/2 x increase
Canned Meats	440	.764	3 x increase
Powdered Whole Milk	10,558	.80	- 12%
Dry Skim Milk	30,883	.356	- 35%
Wheat	518,001	.082	+ 8%
Wheat Flour-Enriched	9,460	.130	- 45%
Soybeans	12,417	.101	6 x increase

Agricultural Exports: Philippines

Products	1975 Quantity	Price ($) Per lb. F.O.B. Port	Volume Trend vs. 1974
Copra	761,147	.102	2 x increase
Crude Coconut Oil	614,387	.169	+ 50%

Source: U.S. Embassy-Manila 5/4/77

SECTION II

INGREDIENT PRICES:

The following prices are bulk landed dock costs, F.O.B. Manila.

Non Fat Dry Milk - Food grade:	₱ 4.49/kg. ($ 616./m.t.) ($ .28/lb.)
Soy Concentrate (Griffith GL-70)	₱ 22.81/kg. (1.41/lb.)
Soy Isolate (Pro-Fam of GPC)	₱ 33.06/kg. ($ 2.05/lb.)

Wheat: The Manila subsidized price to millers is ₱ 2.65/kg.

Source: RFM Corporation, May 1977

CONSUMER DATA

These statistics, when compared to Philippine retail food prices, show the problem which will be encountered with marketing a finished product with a value much above that of rice, corn grits or flour. Approximately 80 percent of the families in the R.P. have income below $700 per year.

While the literacy rate is relatively high, i.e. 82-85 percent, the 1974 per capita national income was ₱ 1834 ($251.25).

Mean Household Income (1971)

	₱	U.S. Equivalent
Urban areas	5,867	$ 803.77
Manila	7,785	1,066.54
Other urban	5,141	704.31
Rural	2,818	386.06

Income Distribution of Families by Group (1971)

₱	$	Percent
Under 1,000	137	17.3
1,000 - 1,999	137 - 274	24.0
2,000 - 2,999	274 - 410	17.7
3,000 - 5,000	411 - 685	20.0
5,000 - over	685 +	21.0
		100.0

Family Food Expenditures as Percent of Income

Item	1971 (%) Total Philippines	Total Rural
Food	53.7	59.3
Alcohol	1.7	2.0
Tobacco	3.3	3.5
Housing	9.4	6.8
Fuel	3.6	3.6

USAID, Manila estimates that 25% of population in R.P. exists at subsitance level (Income).

DEMOGRAPHICS

The 1976 population of the Republic of the Philippines was 43,751,000. This is a 2.9% increase from 1975.

The population by age groups is as follows:

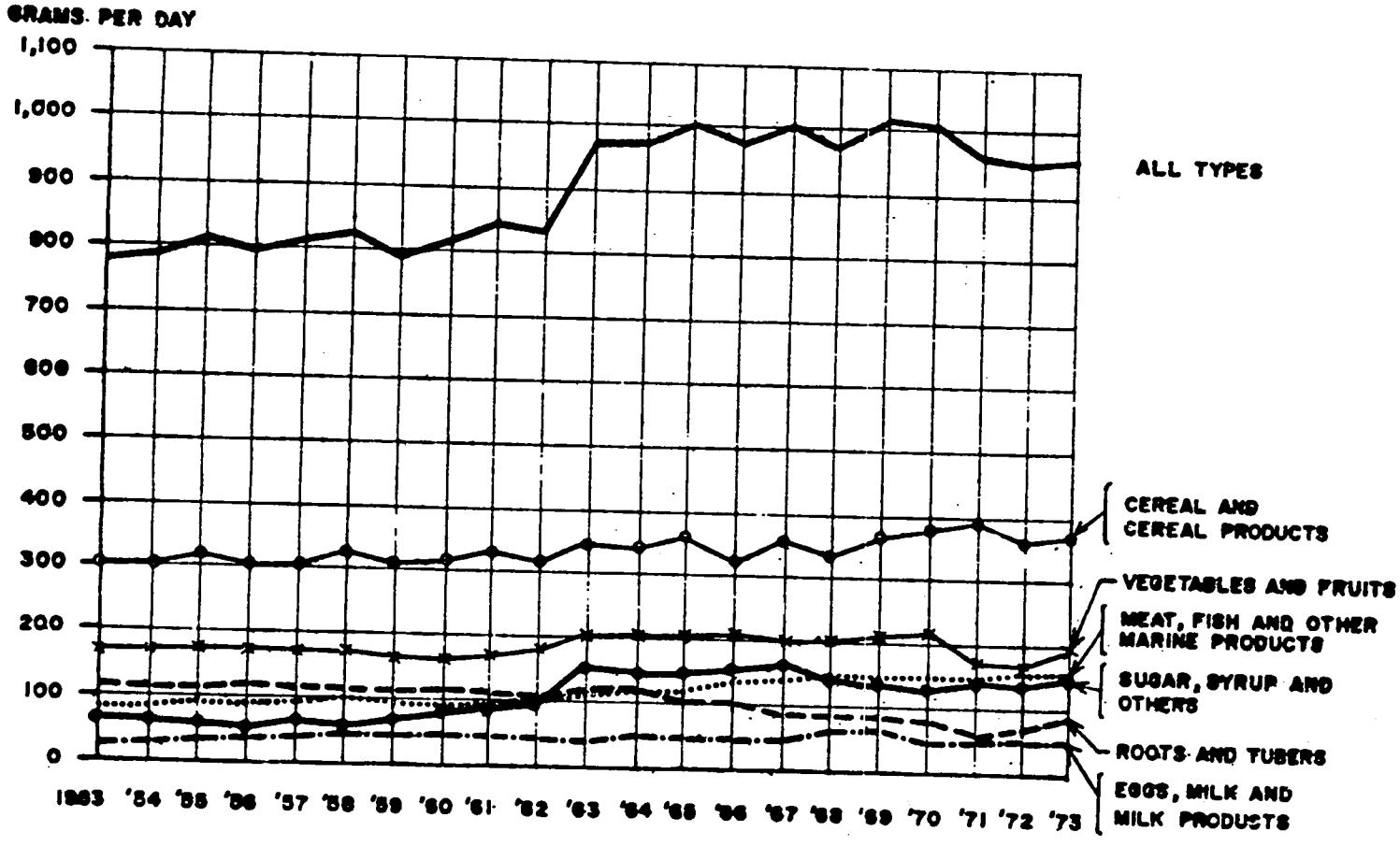
Ages	Percent to Total
0 - 4	16.5
5 - 9	14.8
10 - 19	21.8
20 - 39	28.5
40 - 64	14.9
65/over	3.5
	100.0

Source: Statistical Yearbook of the Philippines, 1976

The production of food in R.P., while increasing has failed to equal the population growth. A more complete profile is graphically shown on page 46 of the September 1976 issue of Scientific American.

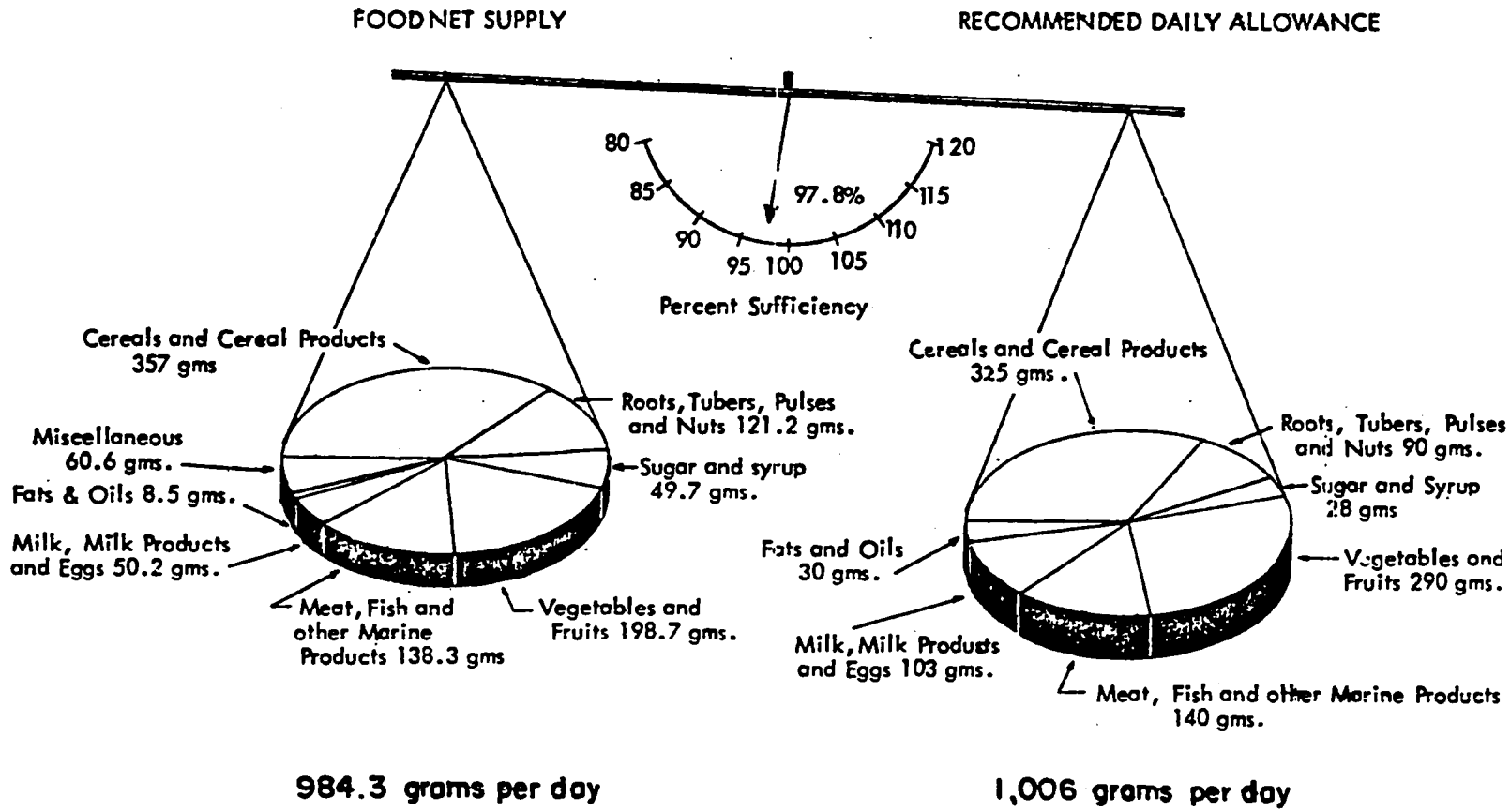
Figure 16.1 and 16.2 present the food supply problem graphically.

Figure 16.1
DAILY PER CAPITA AVAILABLE FOOD SUPPLY, PHILIPPINES: CY 1953-1973



NEDA Statistical Yearbook of the Philippines,1976

Figure 16.2
AVERAGE DISTRIBUTION OF PER CAPITA NET AVAILABLE SUPPLY OF FOODS COMPARED WITH THE RECOMMENDED DAILY ALLOWANCE, CY 1963 TO CY 1973
(In grams, As Purchased basis (A.P.))



NEDA Statistical Yearbook of the Philippines,1976

UTILIZATION OF FLOUR

Bread was introduced to the Philippines by the Americans and baked goods are not heavily consumed, especially by the rural population.

Pan de Sal, considered quite popular in Luzon and often used as an example of a product type which could be used as a vehicle for protein distribution has relatively low consumption outside of Manila.

HOW WHEAT IS USED IN REPUBLIC OF PHILIPPINES (National Statistics)

GRAMS OF TOTAL PRODUCT CONTAINING WHEAT FOUR
PER DAY IN NET GRAMS OF PROTEIN CONSUMED/DAY

Area

Product	North Luzon	Western Visayas----	Mid Luzon	S.W. iMindanao	South Manila	Metro Manila
Pan de Sal	3.79	5.4	5.39	4.56	19.94	43.28
Noodles	3.73	1.5	1.45	.92	2.16	4.57
Crackers	1.69	2.09	2.06	3.05	3.92	2.74
American bread	.47	.99	1.06	.69	0.82	3.88
Cake	.71	.95	1.34	1.22	0.49	0

Source: R. Engle USAID

INFLATION RATES: R.P.

The discussions on investment decisions regarding a Aqueous Process Plant inevitably turn to an expected rate of return on the capital required.

Private firms in Manila consistently started that 18-20 percent would be the expected R.O.I. Basis selected inflation rates recorded for the five year period through 1975, 18% must be considered a minimal rate of return, as a much lower rate, relatively risk free return could be realized simply by storing food stuffs. For example:

Comparative Inflation Rates in Manila, R.P.
Source: "On to the 80's", Published Jan. 1977
by S. E. Asian Science Foundation, Inc.
Economics & Society Series A, Table II

Retail Prices of:	Basis 1970-1975 Reduced to Annual Rates - Percent
All Foodstuffs	18.08
Cereals	19.01
Fish	20.14
Meat	20.58
Eggs	16.50
Dairy Products	15.56
Vegetables/Fruits	15.45
Brown Sugar	12.89

These rates are confirmed by Bureau of Commerce, Central Bank, R.P., which states: "Cereal prices rose at a rate of about 19% a year".

Source: NEAD 1976

Protein Product Margins - Plant Realization

Table XIV of the Process Economics Discussion Section correctly attributes the percentage of sales of Cocopro 1 to the total plant output, and the effect of a ₱2.64/kg. plant realization with sales of 2,025 metric tons annually. The base case gives a reasonable estimated return on investment if capital requirements, operating costs and selling prices of all finished products are as stated at the base case level.

The effective cost to processors of a Cocopro 1 type product will be 18-20% over the ₱2.64/kg., however.

Discussion

The Pilot Plant Report of April, 1977 considers sales tax, packaging and additive costs against the protein products totaling $.013 per pound. These costs are taken as plant costs, and represent 14% of the plant sales price.

The packaging costs used by the plant appear low. The protein products must be packed in relatively costly containers to protect and maintain product integrity. In the case of bulk drums, for example, forty-two gallon drums cost ₱74. each, including liners. If reuse is effected, as proposed by the pilot plant, return expense and handling has not been costed. Reuse might be possible, but if not, single use raises bulk packaging costs to $.022 per pound versus the $.012 per pound shown for total packaging costs by the Pilot Plant Report.

Normal wholesaler (distribution expense) margin for the Philippines is 15%. While the pilot plant study priced FOB plant, the food processor will pay either the plant or the wholesaler this charge, which, based on sales price adds about $.02 per pound to the user cost. (₱321/MT).

The above items will add $.03 per pound to the effective purchase price which processors pay. The cost to users then becomes:

		(Per Kg.)	
		₱	$
	Base Case	2.64	.361/kg.
Add:	Packaging/Distribution	.48	.066/kg.
	Total	3.12	.427

Further expense from the marketing area can be anticipated from returned goods, internal interest charges, damaged product, R&D, introductory and sustaining advertising and promotion, out freight to distributor or docks.

In summary, packaging, marketing and handling cost inputs are likely to dictate at least an increase of ₱1./kg. (30%) additional to the ₱2.64/kg. minimum selling price of the protein products. A ₱2.64/kg. net plant realization, in other words, would not represent the processor's cost. This is assuming an optimal base case situation.

Packaging/Distribution Costs
Inventory Turnover

The following data substantiates the packaging and distribution costs which would need to be considered in marketing Cocopro products.

The inventory movement rates on flour products especially emphasize a need for proper packaging.

Packaging Costs

	₱	$
Foil Pouches (30 gr.)	.12	1.6¢
Foil Pouch (50 gr.)	.15	2.0¢

42 gallon steel drums - cap.
200 litres, 14 gauge - by Camara Steel Company
50.-75. $7.00-10.25 each

Distribution Costs (representative from dealer and company sources R.P.)

Carcar, Cebu to Cebu City ₱.03/kg. - truck - copra
Carcar, Cebu to Manila ₱.06/kg. - truck - vessel
Manila to Dagupan (N. Luzon) 230 km. via truck
Animal feeds, bagged, 25 kg. ₱2.55/unit
Tinned meats/baby food ₱1.30/case
Flour (25 kilo bag) ₱1.30/bag
Manila to Cebu/Davao ₱50.35/cu. meter - containerized
Manila - dock handling charge - 25 kg. unit ₱1.79/bag (dry product - not containerized)

Manila Plant to Manila Dock - truck freight rates:

Item	
Glass product (4-5 lb. case)	₱ .60/case
Tinned meats	₱ .60/case
Flour (25 kg. bag)	₱ .60/case
60 kg. weights	₱1.10/unit

Inventory Turnover Rates

Products - plant to processor and end user - 2-3 months

Processed Meats - plant to sale point 2-3 weeks

Source: RFM Co. R.P.

The necessity to consider the likelihood of wide variance in oil sales realization with its effect on plant investment and return on investment is illustrated by the price per ton history of coconut oil.

ANNUAL EXPORT VOLUME AND FOB VALUE OF COCONUT OIL

1965 - 1975

(Volume in Metric Tons - FOB Value in U. S. Dollars)

	Coconut Oil		
Calendar Year	Volume	Value	Price Per Ton
1965	241,414	$ 70,063,613	$290.
1966	313,150	76,076,030	243.
1967	234,948	58,216,535	247.
1968	270,525	82,256,156	304.
1969	213,793	54,133,360	253.
1970	334,255	95,349,964	285.
1971	405,188	104,923,409	259.
1972	469,045	84,036,548	179.
1973	428,598	151,909,142	354.
1974	433,305	400,925,815	925.
1975	591,600	226,357,212	383.

Note: Rounded Figures.

SOURCE OF BASIC DATA: Trades and Market Department
Philippine Coconut Authority
Diliman, Quezon City

GENERAL CONSIDERATIONS

The Philippine Republic is not unique in the need to search continuously for sources of supply for food which are both nutritious and economical. This is a problem that promises to become more critical throughout the world as the population increases. Since the Philippine Republic is the leading producer of coconuts and the reported consumption of coconuts per capita is lower than it is in some other countries, it is logical that the Philippine government and AID, and Texas A&M Research Foundation should focus on the coconut as the leading candidate as a potential source of food.

Coconut oil is recognized as being one of the better sources of oil, being very stable, a characteristic which is very important in hot climates.

The solids from the coconut are used primarily as a source of animal feed, being processed to form copra. This product, aside from the problems with mycotoxins, has been recognized as an excellent source of protein in animal feeding.

In view of the importance of this crop to the Philippines, and the need for indigenous sources of food, it would seem logical to attempt to develop processes which would retain the original quality of the solids as food from the coconut and to find uses for these in the food system for the entire population.

According to Handbook No. 8 of the U.S. Department of Agriculture, the fresh coconut meat will analyze approximately 50.9% moisture, 3.5% protein, 35.3% fat, and 9.4% carbohydrate of which 4% is fiber. When dried, these figures become 3.5 for moisture, 7.2 for protein, 64.9 for fat, 23% total carbohydrate of which 3.9 is fiber. Thus, for most food purposes, the fat content must be reduced, providing a product that is proportionately higher in protein and carbohydrates in relation to the fat content. The amino acid profile of the coconut is quite good. When coconut flour or higher protein coconut products are added to wheat flour, the lysine content of the total mixture will be improved. Thus, the coconut can provide a good source of protein in the Philippine diet.

It should be recognized that in the Philippines, as in most areas of the world, the primary problem is total food, but when that total food deficiency is met, then we would expect that there would be a need for additional sources of high quality protein. This is in agreement with evaluation by the nutrition community in the Philippines. There seemed to be no specific problems in using the coconut as food when the oil has been extracted, although some of the individuals interviewed did report some objection to the flavor when the coconut products are added to such products as bread or milk where one does not ordinarily expect to find that sort of flavor. This, of course, varies with individuals as it does with other food preferences. Therefore, it is entirely possible that the coconut can provide a good supplementary source of both total food and of a protein supplement when properly processed under sanitary conditions. The critical ques-

tion, however, as brought out in the earlier sections of this report, is a question of whether this can be accomplished economically and at a lower cost than some of the imported foods, such as wheat and milk.

Some nutritional evaluation has been made on the products produced by the aqueous extraction procedure. The results with both rats and chicks show these products to be within the range expected of good plant-type proteins. The best protein efficiency ratio of these products was 2.16 compared with a casein control of 2.50, which is quite satisfactory. The biological value of these products was 76 compared with 84 on the casein control. Further evaluation, such as nitrogen balance in humans, would be very desirable before these products could be used as protein supplements with any degree of confidence.

Frequently, when the food industry evaluates this type of product, some functional characteristics such as water binding, fat emulsion, and so forth are essential if the product is to be useful. Very little of this type of work has been done although it was reported by the Food and Nutrition Research Institute that the products produced by the aqueous process showed no strong functional characteristics and, therefore, should be considered as a nutritional supplement rather than one of contributing functional characteristics.

Interviews with various individuals in private industry revealed interest in this type of product but the question of economics is uppermost in the minds of most of the food industry. The analyses performed in earlier sections of this report indicate marginal economics for both the producer and the user of this type of product. Suggestions have been made which should make it possible to make more detailed economic analyses permitting more accurate evaluation. This should be done before final decisions have been made regarding this type of project.

Certainly much information can be derived from the project undertaken by Cornell University some years ago, in which a drink known as Philsoy has been developed and is now in the market test phase in the Philippines. This is a drink and can be produced in milk processing plants. This product is designed primarily to provide a good source of protein to supplement the diet.

The replacement of the present type of coconut trees with the new hybrid varieties under a project initiated by the Philippine government will undoubtedly increase coconut production very considerably during the next ten to fifteen years. This, of course, will mean a much greater potential as a food supply. Therefore, it is apparent that the Philippine government is dedicated to the increased production and utilization of coconuts. They have the expertise necessary to find solutions to the problems of utilizing the coconut more effectively as food. Only the Philippine government can make the decision as to where this type of program fits into their priorities.

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This team is also very much indebted to the various members of the Philippine government and of industry who were contacted for their willingness to discuss the problems involved in a very frank and objective manner.

Respectfully submitted,

Herbert F. Kraemer

Vaughn Larrison

Harold L. Wilcke

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