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# The Sugar Industry in the Philippines

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AN ANALYSIS OF CROP SUBSTITUTION AND MARKET  
DIVERSIFICATION OPPORTUNITIES

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CANE/ENERGY ASSESSMENT PROGRAM

THE SUGAR INDUSTRY IN THE PHILIPPINES

An Analysis of Crop Substitution  
and Market Diversification Opportunities

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Contributors:

James Sullivan, Director, A.I.D. Office of Energy  
Franklin Tugwell, Program Manager

John Kardyszewski, Study Coordinator

Donald Hertzmark  
Curtis Jackson  
Mead Kirkpatrick  
William Klausmeier  
Russell Olson  
Arnold Paulsen  
Henry Steingass

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Belindia S. Coles

by

RONCO Consulting Corporation

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# THE SUGAR INDUSTRY IN THE PHILIPPINES

## An Analysis of Crop Substitution and Market Diversification Opportunities

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## Chapter One

### SUMMARY AND CONCLUSIONS

This report presents the findings of a team of specialists that visited the Philippines in late spring 1986 to review crop substitution and product diversification opportunities for the sugar industry.(1) A principal objective of the team's work was to identify areas that appear to merit more intensive analysis as part of USAID's effort to assist the Philippine Government in responding to the continuing crisis in the sugar industry.

The team interviewed many representatives of public and private organizations involved in the production, processing and marketing of sugar, molasses, alcohol and associated products. Team members visited nine representative mills on Luzon, Negros and Mindanao, four distilleries, two aquaculture farms, and two experimental livestock operations. They also visited research centers working on the development of commercial by-products and co-products from the sugar industry. Without exception, those with whom the team met were generous with their time and prompt in responding to requests for information. The team also benefitted at every stage from help provided by the Philippine Sugar Commission, now transformed into the Sugar Regulatory Administration (SRA).

The report contains four parts. The first summarizes the team's findings and reviews recommendations and options; the second addresses the broad problem of crop substitution on sugar lands; the third analyzes electricity production and fuel displacement opportunities; and the last treats the option of producing animal feed from sugar cane.

#### KEY FINDINGS

The study team's overall assessment of the sugar crisis in the Philippines is in agreement with that presented in a recent analysis by the World Bank: a variety of causes, including chronically low world prices, reductions in U.S. quotas, corruption, poor policies, and inefficiency, have forced the industry into a devastating depression from which it cannot recover without major adjustments.(2) Production of sugar must contract to the point where it satisfies only the 1.2-1.3 million tons required by the domestic market plus exports to fill the U.S. quota. Sugar that is produced must be grown, milled and refined efficiently. This means that some mills and factories must be closed and new uses found for the land and labor employed until recently in the production of sugar.

As noted, the work of the team focused on two key problems: 1) identification of crops to be substituted on lands withdrawn from sugar production; and 2) identification of co-products and new technologies to supplement the income of cane producers and millers or allow them to maintain a stable income by continuing to grow cane but producing products other than sugar.

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The conclusions of the study, detailed in the chapters that follow, are summarized here.

There is one broad recommendation that cuts across the different themes of this report: the need for urgent action to assist communities on the "sugar island" of Negros, where the crisis has caused the most concentrated damage. Team members were impressed with the commitment of many private and public leaders of that island to search for ways to rehabilitate their economy and create employment opportunities for the hundreds of thousands who have been affected in the last two years. There is strong interest in crop substitution and product diversification, but time is short--and actions must be taken within six months to a year. Failure of the government to provide tangible evidence of improvement and the prospect of productive work for workers of the island, whether in private sector or government-sponsored activities, could lead to a situation in which constructive reform will no longer be possible.

The principal finding of the team is that crop substitution and market diversification are both difficult and expensive, and are likely to proceed slowly absent vigorous action to stimulate and support the efforts of private growers, large and small, to find new crops for their land and new products from their cane. It is true that sugar production has decreased dramatically in the last two years, but this appears to have occurred primarily because farmers have decided to leave large acreages unplanted and unharvested, not because they have turned to new and productive uses for their soil. Low world prices, mismanagement of sugar markets, and the lack of financial credits have all contributed to this outcome. Displaced workers have been largely unable to find other livelihood.

Crop substitution and market diversification face obstacles that are often poorly understood by policymakers unfamiliar with the sugar industry and with the incentives that motivate farmers, especially in hard times. In a nutshell, cane growers are reluctant to switch to other crops because sugar remains the best crop when all the variables are taken into account. These include long-term profitability, technical and financial risk, security of land tenure, and the allocation of scarce expertise, managerial resources and capital. The same disincentives retard experimentation with new products that can be derived from cane itself.

Further, there is no single crop or set of crops that form the "ideal" alternative to sugar. The major food and feed crops hold some promise--rice and corn, in particular--but the growth of each is likely to be constrained by agronomic or market factors. There is, in fact, no single "solution" to the problem; a successful process of diversification and stabilization will involve different combinations of crops and co-products, and will take many years.

It is therefore unlikely that the areas heavily engaged in sugar production can make needed adjustments without significant commitment of resources to the preparation of feasibility studies, the evaluation and development of markets, and the funding of new agricultural and agro-industrial ventures. Although these ventures must be undertaken by large and small private businesses, the government can assist by

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mounting a commercialization program carefully targeted to sugarland diversification. Public infrastructure investments will also be needed in many areas of the country.

Fortunately, as the succeeding chapters illustrate, Philippine research centers, experiment stations and agribusiness concerns have accumulated a great deal of information on alternative crop systems and their performance in different ecological zones. This can prove an invaluable resource if properly utilized. Reliance on foreign specialists may be appropriate to help introduce some specialized crops, and to advise on marketing opportunities and strategies, but for the most part the Philippine government and private growers can rely on the country's own information resources and research inventory for decisions.

### CONCLUSIONS

The study team makes the following recommendations for action in response to the ongoing crisis in the Philippine sugar industry. The recommendations are divided into two broad groups: 1) concrete, immediate responses that can be expected to show results in the near term (0-5 years), and 2) programs of investment in research, institution-building and infrastructure development, as well as broad changes in macro-economic policy that will be needed in the long run if agricultural programs to displace sugar are to succeed.

#### I. ACTIONS IN RESPONSE TO THE IMMEDIATE CRISIS

##### A. The promotion and support of private crop substitution and market diversification ventures.

As noted, only a wide-ranging process of investment in new agricultural ventures by cane farmers will lead to the adjustments that are needed. To achieve this goal, the team recommends the creation of an independent, high-level commission or task force charged with promoting and supporting new ventures in crop substitution and product diversification.

The team recognizes the complex array of institutions which already exist. Several existing agencies are appropriate candidates to house the commission. The job, however, might be best handled by an organization that 1) brings together the heads of the key agencies (i.e. SRA, NEDA, Ministry of Agriculture, and so forth); 2) is temporary, i.e., with a lifetime of five years; 3) reports to the President; and 4) is presented to the nation as a response to the crisis in the sugar sector. A special secretariat, attached to the President's Office, could serve this purpose well.

This commission would be empowered to: a) support feasibility studies to identify options that are viable on a commercial basis; b) assist growers and millers in developing bankable business plans; c) provide "seed money" loans and/or partial guarantees or equity participation where commercial financing is unavailable; d) counsel the government on policies and programs that would assist the diversification effort.

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In providing these services, the commission should pay special attention to the needs of the many small and medium-sized growers engaged in cane production since these are likely to be both the most seriously hurt, and the least likely to have resources for experimentation. The commission should also make a special effort to solicit requests for support from cooperatives, community groups and other not-for-profit organizations most concerned about the problems of small and medium-sized growers.

The mixture of large and small growers in sugar areas and the need for infrastructure and processing support for many new crop and product-line diversification ventures suggest the suitability of the Nuclear Estate Smallholding (NES) model in many instances. In this arrangement, a central estate/processing facility receives financial and technical assistance contingent on its ability to assist smallholders in making the transition to the new activity, providing extension services, education concerning management methods and grading standards, and even loans.

Although widespread and successful experimentation with new crops is unlikely to occur without the vigorous leadership of estate owners and agribusiness firms, ventures of this kind must be promoted with a view to the larger development problems of the Philippines, including: 1) the need to avoid displacing small and medium-sized farmers and further worsening the country's highly skewed distribution of wealth and property; and 2) the need to avoid enlarging the already large pool of itinerant, semi-employed rural workers. Where product lines (e.g. rice and corn production) do not lend themselves to NES-type arrangements, special government programs to help smallholders should be a high priority.

This study surveys the various crops and products that have been suggested as substitutes for sugar cane, and recommends several of these as candidates for the first commercialization efforts of the commission. In addition, the commission should examine possible alternative uses of closed sugar mills (e.g. conversion to feed production).

Finally, the team recommends that the commission undertake further study of the sugarland diversification problem by commissioning more general studies covering, among others, the following topics: a) the incentives leading large and small sugar producers to continue in production; b) the role of pricing policies, especially as they affect rice and corn (see below); c) infrastructure and irrigation needs, especially in more marginal lands; d) and the development of domestic and export marketing systems for substitute crops, including the setting of quality standards and grading systems and the estimation of market saturation levels.

### **B. Assistance to communities faced with forced adjustment due to government decisions to close sugar mills.(3)**

The slow and difficult process of crop substitution and product diversification, involving as it will dozens of crops and hundreds of separate commercial studies and investment decisions, will occur too slowly to provide relief in areas where isolated

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sugar mills are closed by the government.(4) For these areas the team recommends that the government sponsor the creation of community task forces, providing teams of technical specialists and financial support for a more rapid evaluation of, and investment in, alternative crops.

These teams could be composed of specialists on sugarland diversification, perhaps formed by the commission suggested above and staffed by a combination of specialists. Their job would be to work with community groups to find immediately available commercial alternatives for those faced with loss of their sugar processing facility, and to search for possible investment funds for new ventures. The teams would also assist in the critically important identification of markets for the resulting products. The crops and products, of course, would differ for each region and community affected. As with the broad promotion of new ventures, the community task forces should pay special attention to the problems of the small and medium-sized growers and to opportunities to create NES arrangements that might provide continuing support for medium and small farmers.

### C. Analysis of the feasibility of generation of electricity by sugar mills for the Luzon grid.

The team feels there are several specific opportunities for product diversification significant enough to warrant preparation of pre-feasibility studies in the short term. These opportunities are attractive partly because they involve the transfer and/or testing and adaptation of new technical options and partly because, if proven feasible, they promise to have a significant impact on the prosperity of those engaged in cane production.

The first of these is the production of electricity for the grid at sugar mills located on Luzon using bagasse and field residues burned in more efficient turbo-generator systems. Electricity has been generated at sugar mills as a co-product for sale to the grid in Hawaii for several years. A model can be found for Luzon in Jamaica where a final feasibility study has just been completed.(5) The goal of a pre-feasibility study, would be to establish the technical and economic feasibility of power sales to the grid by the sugar industry, leading to more detailed analysis and possible private investment in one or more facilities.

### D. Analysis of the feasibility of commercial fuelwood displacement by the use of cane residues on Negros and elsewhere.

Site visits by team members to Negros suggest an immediate opportunity on that island to displace large quantities of commercial fuelwood--and some imported oil--by the collection and combustion of cane field residues. This would help alleviate a severe deforestation problem, increase employment in a sustainable fuel production industry while reducing the cost of steam production for the operation of distilleries, sugar refineries and other commercial operations.(6)

Studies sponsored by USAID in Jamaica and Thailand, supported by an ongoing trash-collection demonstration program scheduled in Louisiana, Texas, and Jamaica, suggest that this fuel can be harvested, stored and used at a price significantly

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below that of competing fuels.(7) A pre-feasibility study would indicate whether this option makes economic sense on Negros and would suggest which of several technical alternatives are the most attractive.

### **E. Analysis of the feasibility of the use of cane fiber and juice for the production of feed for an invigorated livestock industry.**

The displacement of imported animal feeds and feed ingredients by domestically produced sources of protein and fodder appears to be an attractive set of product diversification opportunities for the Philippine sugar industry. Proven technologies are available for converting molasses and cane juice to yeast protein which is widely acceptable as a substitute for soybean meal. New yeast strains have also been developed that use distillery slops as a feedstock, thus producing valuable feed while helping manage a serious waste-disposal problem. Hydrolized bagasse and field trash can substitute for high quality forage for ruminants, suggesting the possibility that confined feedlot operations for cattle can be developed in association with, or in place of, sugar processing facilities.

Detailed costs, benefits and requirements of a venture producing protein feeds could be established quickly with a feasibility study. Potential profits from a successful feeds venture should be large enough to attract private investment.

## **II. ACTIONS TO PROMOTE AND SUSTAIN AGRICULTURAL DIVERSIFICATION OVER THE LONG RUN**

The extensive crisis in the sugar industry requires crucial participation by the Government of the Philippines through policies and programs to help the industry stabilize and diversify into other crops and products. There are a number of steps the Government can take to stimulate and sustain a successful diversification program. Among the most important of these are the following:

### **A. Promote and support changes in government policies affecting agriculture in general and the sugar industry in particular.**

If a robust recovery of Philippine agriculture is to occur, broad policies favoring the producers of agricultural products are vital. Past policies, for a variety of reasons, have favored food consumers, urban dwellers and manufacturing interests. These include both exchange rate policies and price policies, especially for feed grains and protein.

Currency devaluation would have the general effect of reserving more of the domestic market for Philippine producers while helping capture more of the international market for the country. Appropriate and stable price policies for grains are especially important in the livestock and feed industries, an important diversification option. Accordingly, the team recommends an examination of the possibility of stabilization programs with floor and ceiling prices for these products (yellow corn, grain sorghum, rice bran, cassava chips, and high-protein feeds like soybean meal, copra meal and ipil-ipil leaf meal).

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Finally, the government should clarify the application of its land reform policies to lands now in sugar and to lands that may be taken out of sugar. The large and medium-sized farmers are concerned about how land reform laws will be applied. There is widespread fear of confiscation of land if crops other than sugar cane are grown or if any of the land is operated under lease or share arrangements.

**B. Bolster government research and extension programs affecting crops that are good candidates for diversification.**

In the intermediate and longer term, it will be important to continue and accelerate government programs to develop varieties (e.g. of soybeans) and technologies (e.g. crop systems) that are appropriate to the diverse soil and climate situations in order to make alternative crops profitable for farmers and more competitive in world markets.

**C. Support programs in infrastructure development.**

A wide range of infrastructure improvements will be necessary for the success of diversification programs. Irrigation, in particular, will be important. Plans for additional irrigation development should be drawn up with the diversification goal clearly in mind. Among other things, improvements in farm-to-market roads, rail terminals and port facilities are all needed and will require public investment.

**D. Make a clear commitment to the promotion of private agribusiness investment in alternative crops.**

Success for many crop alternatives will require private investment in commercial facilities for processing and marketing. Government policies should encourage the development of agribusiness supportive of this goal. These include, as a minimum, a market grading and inspection system with high standards and strong enforcement, and a good market intelligence system. For the development of commercial crops for export, government policies may need to encourage businesses to systematically explore the demands of major export markets. It may be advisable for the government to establish trade development offices in key foreign markets to promote products and provide up-to-date intelligence for Philippine producers.

Many of these are the same kinds of activities that the team envisions for the special diversification Commission, described above, and can be institutionalized in appropriate government agencies for long-term purposes. The Philippines may want to draw on the experience of other successful private-sector agricultural promotion programs, such as that of the State of Hawaii in the United States. The Government may also want to develop appropriate levers (e.g. loan or technical assistance programs) to strengthen incentives for estate owners and agribusiness firms to create NES production systems and otherwise assist small and medium-sized farmers.

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### Notes

- (1) The study was prepared by the Ronco Consulting Corporation under contract with the Bureau for Science and Technology, USAID. The program was initiated and supported under Alan Jacobs, retired Director of the AID Office of Energy. The team included: Dr. Franklin Tugwell, Ronco Manager of the AID Cane Energy Assessment Program; John Kadyszewski, energy technology specialist with the AID Office of Energy; Dr. Russell Olson, Agricultural Economist and leader of the agriculture group; Curtis Jackson, specialist in row crops; Mead Kirkpatrick, specialist in perennials and the marketing of agricultural products; Dr. William Klausmeier, alcohol and animal feeds specialist; Dr. Arnold Paulsen, agricultural economist; and Dr. Donald Hertzmark, energy economist. Henry Steingass, cane energy specialist with the AID Office of Energy, contributed to the preparation of the chapter on feeds; Betsy Amin-Arsala, project specialist with the Office of Energy, contributed editorial support.
- (2) See World Bank Report No. 6042-PH, "The Philippines Sugarlands Diversification Study," (May 30) 1986.
- (3) This recommendation assumes that the Government of the Philippines will:
  - Quickly decide on the disposition of lands foreclosed by banks and lands mortgaged but not yet foreclosed. This is the first step to get these lands back into production and to remove the uncertainty that now afflicts many growers.
  - Quickly and authoritatively decide which mills will close and announce supportive actions for the communities affected and, if appropriate, for the mill owners. The lead time in reducing cane acreage is long, since planting begins immediately after the harvest starts in the fall. Once a new crop has been planted, the mill must be allowed to grind through the next season if the investments in the new crop are not to be lost.
- (4) This refers to areas where there are no other mills and therefore no market at all for farmers growing cane once the mill is closed.
- (5) See Jamaica Cane/Energy Project: Feasibility Study, prepared by Bechtel Corporation and Ronco Consulting Corporation, a study funded by USAID and the U.S. Trade and Development Program, September, 1986.
- (6) Several cane farmers and mills on Negros have already expressed interest in this alternative, citing the serious ecological damage caused by illegal wood gathering: lowering of the water table, siltation of rivers and streams, and reported changes in the climate of the island.
- (7) See Cane Production for Sugar and Electric Power in Jamaica (Washington, D.C.: USAID), October, 1984; and Electric Power from Cane Residues in Thailand: A Technical and Economic Analysis (Washington, D.C.: USAID), May, 1986.

## Chapter Two

### Crop and Product Diversification/Substitution Alternatives

Philippine sugar cane production, relatively stable in the past despite wide fluctuations in world sugar prices, underwent sudden and disorderly contraction beginning in crop year 1984-85. Area and production, which averaged 442,000 hectares and 2.4 million metric tons in the five year period 1979/80 through 1983/84, declined to 1.7 million metric tons on 385,000 hectares in 1984/85. In the current year (1985/86) production is expected to decline to 1.3-1.5 million metric tons on an area of only about 321,000 hectares (Table 2.1).

World sugar prices, which averaged more than 28 cents per pound in 1980, dropped to below five cents in 1984/85. About ten years earlier the Philippine sugar industry faced a year of burdensome excess stocks followed by low prices, but no substantial reduction in production or employment occurred. During the current period low world prices, a complex of factors has made it impossible for the Philippines to maintain sugar production and employment. Reduced production resulted from two principal causes: denial of credit to some planters and anomalies in the government's sugar marketing practices.

The problem of very high interest rates (as high as 45% in 1984) combined with several months delay in receiving payments for sugar sold by the National Sugar Trading Corporation (NASUTRA) made many planters unable to repay in full their 1983/84 loans. Those with few assets were unable to obtain production loans for the following crop year. New sugar production loans in 1985 decreased to only one-third of the 1983 level. Consequently, the use of fertilizers on sugarcane declined by 30%, reducing yields. Lower yields also resulted when growers increased extra ratooning to avoid the costs of new plantings. Of the large reduction in sugar area, some small acreage moved to other crops, but most remained idle. An estimated 150,000 sugar workers are unemployed and most of the rest are seriously underemployed because of shorter milling seasons and less planting and weeding.

The crisis in the sugar industry, particularly in the provinces and communities where sugar production is the primary economic activity, has been devastating, sharply cutting standards of living and in some areas causing starvation and serious malnutrition. These conditions exacerbate the already alarming "peace and order" problem in those areas.

World sugar prices are low and are expected to remain below full costs of production for the next several years. The Sugar Regulatory Administration (SRA) is considering a quota system to limit production to the level that can be sold at an economic price - i.e. that which will meet only domestic requirements (0.9 to 1.1 million metric tons), the U.S. sugar quota (currently about 0.2 million metric tons) and a modest reserve. The target production level for the 1986/87 season has been

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set at 1.3 million metric tons. This will require no more than 55% of the land area that had been devoted to sugar cane in the 1979-83 period. Planters will, presumably, be permitted to grow sugar in excess of their quotas, but only for export at world market prices which at this time seem likely to be low for the next few years.

Table 2.1  
Area Harvested, Sugar Production, and World Sugar Prices  
(Philippines 1970 - 1986)

Crop Year	Area Harvested <u>a/</u> (000 ha)	Sugar Production <u>a/</u> ( million metric tons)	World Prices <u>b/</u> (U.S. ¢/lb)
1970/71	408.4	2.1	4.50
1971/72	420.3	1.8	7.27
1972/73	447.3	2.24	9.45
1973/74	474.3	2.47	30.04
1974/75	529.9	2.39	20.49
1975/76	550.1	2.88	11.58
1976/77	533.5	2.69	8.71
1977/78	490.0	2.33	7.82
1978/79	416.7	2.29	9.65
1979/80	417.6	2.27	28.66
1980/81	455.4	2.31	16.89
1981/82	453.4	2.41	8.40
1982/83	441.3	2.46	8.50
1983/84	445.1	2.30	5.39
1984/85	384.7	1.70	N/A
1985/86	321.3	1.50	N/A

Source: World Sugar Journal

a/ Source: PHILSUCOM and FSA

b/ ISA daily average price in U.S. cents per pound.

As these data suggest, farmers in the Philippine cane growing area do not have the luxury of decades of trial and error to improve their practices and respond to changing market conditions. Aware of needed adjustments, many are already keenly interested in means to improve their livelihood and will view efforts to introduce new technologies accordingly. In general, the larger planters will be in the best position to take the necessary business risks associated with new ventures, and will likely be the ones to establish processing facilities with which smaller planters and farmers can contract for the sale of their crops. In locations where all of the growers have small acreages, cooperatives can be organized and, with appropriate guidance, obtain financing to build processing facilities and secure astute operating management.

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One variation of these organizational forms is the "nucleus estate smallholders" (NES) scheme, which has worked very well in sugarcane plantation areas and former sugar estate locations. NES is particularly well suited to situations in which smallholders require special support if they are to take advantage of new technologies. In NES schemes, the central processing company normally farms from one-third to one-half of the total acreage serving the processing facilities. The smallholders, or independent growers, are attached to the processor by a freely negotiated contract, wherein the processor exercises some control over the quality, quantities and timing of delivery of crops from the various growers to the facilities. The "nucleus estate", which is owned and farmed by the processor, serves to guarantee the processor a minimum production of specific commodities at quality levels and production costs over which he has full control, in order to secure his investment in the processing facilities. It also serves as an example for the growers of production methods and standards, and of procedures for crop quality assurance. Where NES arrangements are created with outside (public or private) financial and technical assistance, operators of the nucleus estate can be required to provide necessary extension support for small holders as part of the initial agreement. In effect, such arrangements allow the introduction of new technologies while facilitating the success of smaller farmers.

Given the bleak future for sugar, the critical issue is how to achieve a reduction in sugar output while at the same time minimizing the economic costs of changing the agricultural base, and the social adjustment difficulties that are inherent in such change. Four strategies have been proposed for adjustment and conversion of the sugar sector: 1) efficiency improvements in cane production so as to reduce the costs per ton of sugar and make the Philippines more competitive in sugar markets; 2) rationalization of the industry to reduce overall production in order to serve only the domestic market and projected U.S. quotas; 3) product line diversification for sugar producers; and 4) crop diversification and substitution in sugarcane areas.

This chapter concentrates on the last of these, i.e. identification of crops and products that might be feasible and economic alternatives to sugarcane. This assignment includes a review of certain conventional seasonal field crops, as well as tree and fruit crops, analysis of their cultural adaptability and economic attractiveness and requirements for introducing them successfully in the sugar growing areas. The report reflects the judgements of team members, based on visits to mills and plantations in major sugar producing areas (Central Luzon, Southern Tagalog, Negros, and Bukidnan in Mindanao), a review of information from other sugar producing areas, and discussions with private businessmen, government officials and agricultural scientists at Philippine research institutions.

### 2.1 Constraints to Crop Diversification and Substitution

The substantial reduction in sugar cane production since 1983/84 involved little real crop diversification. It was mostly a contraction of sugarcane area and yields in response to high interest rates, shortages of credit and delayed payments for sugar. There was little crop substitution. Much of the land remained idle. Some planters had no credit for planting either sugar or substitute crops. Some reduction was by planters who had lost access to their land either through foreclosure or as a result of insurgency or invasion by squatters.

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Diversification is constrained by several factors. Widespread fear among planters of large risk and uncertainty associated with future market prices of alternative crops is a major disincentive. Although historical world sugar prices fluctuate widely, since World War II sugar has consistently provided the best income option for Philippine planters. If planters have expectations that world prices will again be attractive they will not be inclined to substitute crops which require specialized fixed investments that cannot readily be converted back to sugar production. It appears that only a few of the most innovative have made permanent shifts out of sugar production. Although innovators have demonstrated the possibilities, others will not follow unless they can be assured of technical success and profitable prices from alternative enterprises.

Seventy five percent of the sugarcane planters are small operators, with less than 10 hectares. They plant about 22 percent of the cane area. The five percent of the planters with 50 hectares or more plant 43 percent of the total cane area. Quite different problems of diversification confront the small and large farmers. It will be difficult for the small farmers to introduce new crops successfully without technical guidance, credit, input support and marketing services.

Concern over how the land reform laws will be applied is a barrier to change for larger sugar planters. The threat of land confiscation is considered greater if crops other than sugar are grown or if any of the land is operated under lease or share arrangements.

The Philippines has a strong network of institutions doing research on agriculture, forestry and livestock problems. Technologies for producing, processing and storing a wide range of crops with potential as substitutes for sugarcane have been developed and tested. Nevertheless, successful introduction or expansion of many of these crops by sugar planters may be difficult in specific locations. The practical packages of complete production elements and locally adapted varieties have not been determined and assembled for many crops.

Sugarcane is, agronomically, a crop that is relatively drought tolerant and disease resistant. It is a crop that is processed where it is grown into a stable food product capable of being stored in standard, unspecialized, commercial structures at ambient conditions for long periods. There are few high value crops with similar characteristics. It is therefore to be expected that where sugarcane is extensively produced to the general exclusion of other than subsistence crops there is likely to be little in the way of commercial infrastructure with which to facilitate the processing, transport and marketing of alternative crops and finished products. This situation applies particularly to most high value export items. For this reason, infrastructure factors must be evaluated before diversification substitution options can be selected.

### 2.2 Crop Substitution Priorities

The principal criteria in identifying promising crops for diversification are profitability for the producers and economic benefits to the Philippine economy. Sugar has been one of the country's important earners of foreign exchange. At

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current world prices, production beyond domestic requirements and the U.S. sugar quota will be unprofitable to producers and uneconomic for the national economy. However, it is likely that world sugar prices, which are subject to wide cyclical fluctuations, will at some time in the future again be attractive to producers and have a positive comparative advantage as in the past--at least for a short time. This suggests that there may be advantages for many planters in selecting crops for substitution that require minimum fixed investments and which permit flexibility for shifting in and out of sugarcane production.

Crops which are well adapted to agricultural conditions but which are important import items in the Philippines are especially interesting candidates for diversification programs. Crops which use only, or principally, domestic resources in their production provide local employment and save scarce foreign exchange. For example, the Philippines has been importing substantial amounts of corn and protein feeds for its livestock industry in recent years. Crops which can replace those imports may be good substitutes for sugarcane in some regions.

The Philippines has traditionally been a large exporter of products from coconuts, oil palm, forests, and fruit trees as well as sugarcane. The country has the soil, climate and population for growing many other crops. To justify producing them in excess of domestic requirements, however, the country must be able to compete with other producing countries in world trade.

The direct resource cost (DRC) is a measure used in several studies of economic policy and agriculture in the Philippines. DRC is defined as the ratio of domestic costs per unit of a commodity to its price minus foreign costs per unit. The ratio of the DRC to the (shadow) foreign exchange rate indicates the efficiency of the commodity in generating foreign exchange. If the ratio is less than 1.0 the commodity has a relative comparative advantage.

Several economic studies have been undertaken of the comparative advantages of some of the major crops and livestock enterprises in the Philippines. Generally these have analyzed the relative comparative advantages at the national level. One such study by L.A. Gonzales (1) ranked commodities and enterprises by regions and provinces on the bases of their expected private and social profitability. Based mainly on a national farm management survey, it estimated the relative comparative advantages of several commodities in all regions under different agricultural production systems. The commodities and production systems were then ranked within and across regions based on their private and social profitabilities. This allowed identification of specific production systems which were financially viable and economically efficient in specific regions. The study indicates that technologies exist for a wide range of crops and enterprises which can be profitable private and social substitutes for sugarcane. It is a useful guide to where certain crops may be successful. However, trials and demonstrations are still needed to reduce planter uncertainty and provide more complete technology packages. These should be tailored to diverse local agro-climatic conditions and used as a basis for building market conditions required for successful implementation of a diversification program.(2)

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### 2.3 Crops Suitable for Diversification

No single crop will be the best replacement for sugarcane. Rather, it will be a mix of short-term and long-term, as well as traditional and non-traditional, crops for both the domestic and export markets. The process of change and adaptation should be a continuing one; less profitable products being replaced by more viable crops on a field by field basis only as fast as the level of productivity and agribusiness expertise develops.

Sugarcane is likely to remain the principal crop on farms within 30 kilometers of the operating mills. Diversification may involve introducing other crops largely in a multiple cropping system. Some crops, such as mung bean, which have a relatively short growing season, are likely to be important for intercropping with sugarcane rather than as substitutes for it. Intercropping is an effective way to increase crop production during the first few months of the cane crop without decreasing cane production. Other annual field crops, such as corn, rice and sorghum, may replace some of the sugarcane if good markets exist. However, near the mills the team expects a sugarcane-based cropping system to persist. More effective crop sequences in multiple cropping systems can be developed by farmers and by research programs through testing of additional sequences which will allow planters to select their favorites in light of biological, economic and social criteria.

Some of the crops that seem to have good potential for meeting deficits in domestic demand, thereby saving foreign exchange, are discussed in Section 2.4. Section 2.5 discusses crops which appear to have good potential for export.

The crops considered for domestic use include food crops for which there will be expanding domestic demand because of the high rate of population increase and expect economic growth and livestock feed crops, which have a strong demand derived from the increasing demand for livestock products. (See Chapter 4 for a discussion of the overall market for livestock feeds in the Philippines.)

The Philippines has a well established commercial poultry industry using modern technology, including improved breeds and efficient rations. Similar, the commercial hog industry is well established and using modern technology. Both of these industries require high energy concentrates and protein feeds. Domestic production of these feedstuffs has been inadequate, requiring large feed imports of corn and soybean meal for these industries. Lately there has been much interest in commercial prawn production for the export as well as domestic market. This expanding industry will also require high quality protein feeds, which are now imported. The value of imported animal feeds in 1984 was \$94 million. We believe these feeds can be produced economically on lands now in sugarcane, with substantial savings in foreign exchange.

Beef cattle production is primarily a backyard operation in the Philippines, with animals fed largely field wastes and by-products with little or no concentrates. There is a small commercial cattle feeding industry producing about 25 percent of the beef marketed. But most of this is not well developed in the sense of using improved livestock breeds and good feeding and management practices. Much of the

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high quality beef demanded by the restaurant and hotel trade, as well as lower quality meat for the fast food industry, is imported. Beef imports in 1982 amounted to 7.45 thousand tons, costing about \$17 million of foreign exchange.

The government plans to help the beef industry by developing existing government stock farms, restocking them with breeding animals of improved genetic quality, and production of calves for dispersal to small farmers for breeding and fattening. Apparently breeding animals from this operation will also be made available to the larger commercial beef ranchers to increase the quality of beef herds generally.

Livestock operations offer an especially good opportunity for planters with small acreages and surplus family labor to increase their farming intensities and incomes. Many of these small farms are located on marginal, sloping lands which are subject to erosion and contribute to deterioration of the watershed. Integrated crop/livestock farming systems can profitably incorporate soil-building and fertility-restoring crop rotations and cultivation practices. Small farms of 2 or 3 hectares can be quite profitable with a combination of poultry, hogs and ruminants (cattle or goats). Such combinations can make efficient use of family labor throughout the year and provide a market for crop residues as well as forage and grain crops produced on the farm.

The government's proposal for developing the beef industry includes a system for distributing the calves produced on the government breeding farms to small holders under an arrangement where the animals are returned after they have grown to market weights. The farmer will be paid for the gain in weight. Such an arrangement spares the farmer the problems of credit and marketing. Similar arrangements could be made by the private sector, by individual entrepreneurs or cooperatives, for making improved technology available to small farmers for poultry and hog production as well. Organizations such as First Farmers Cooperative on Negros does distribute day old chicks and poultry feeds to small operators. Such organizations could also provide technical assistance and marketing services to small farmers.

One barrier to development of a feeder cattle system is the lack of a functioning meat grading system. If the government wants to encourage improved meat quality to displace imports, it needs to enforce a meat grading system based on quality and backed by adequate and consistent inspection. Otherwise, the economic incentive to breed better cattle and feed them properly created by differential pricing based on meat grades does not exist.

### 2.4 Potential Substitute Crops for Domestic Markets

The crops discussed in the following paragraphs are some which it appears can be grown economically to satisfy requirements of the domestic market. We believe that eventually most of the land taken out of sugarcane will be used for rice and corn production. Over the long run, these two crops will have good production potential and good private as well as social profitability prospects in all regions. There are proven technologies for both crops that are suitable for small as well as

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large farmers. Several of the other crops described below may offer very good economic opportunities but may require special facilities for post-harvest handling, processing and marketing. Several of the high value crops have quite narrow domestic and export markets. A relatively small expansion in area, however, may be possible.

Rice: All aspects of the production and marketing of this crop are quite well understood. The crop is supported by a very good infrastructure, including research and development efforts. The Philippines experienced a healthy growth rate in rice production of 3.81% per year from 1961-1980, achieving marginal self-sufficiency by 1980. Since then high fertilizer prices and weather calamities resulted in deficits, making it necessary to import about 400,000 metric tons in 1984 and about 300,000 metric tons in 1985. Considering the high rate of population growth (about 2.65% per year) and the fact that per capita rice consumption rises as incomes rise (for each 1.0% increase in real national income, it is estimated that per capita rice consumption will increase by 0.10%), if the economy grows by 5% per year, per capita demand for rice will increase by 0.5 percent. A fairly high rate of increase in rice production (of about 3 percent) must be maintained if the Philippines is to meet demand requirements of growth in population and income and remain self-sufficient.

A recent study by the International Food Policy Research Institute (IFPRI) (3) assessed food demand/supply prospects for developing member countries of the Asian Development Bank. For the Philippines the study projected an increase in demand for paddy rice from its average annual level of 7.043 million metric tons in 1976-80 to 12.14 million metric tons by the year 2000 (See Table 2.2). The nearly 3.0 percent annual increases in production required can be achieved by some further increases in use of improved varieties and technology, but it will require a substantial increase in land area planted to rice. In 1982/83 the total area in rice was 3,300,00 hectares. Of this, 1,749,300 hectares were irrigated; 1,551,000 hectares were rainfed. The IFPRI projections assume that ongoing and proposed irrigation programs will be completed and that by the year 2000 irrigated rice area will increase to 2,697,100 hectares, that the rainfed rice area will decline to 1,208,000 hectares, and that the total rice area will be 3,905,000 hectares - an increase of 605,000 hectares. If proposed irrigation programs are not carried out, a larger area of rainfed rice will be required to meet demand requirements.

Corn: Hybrid and improved yellow corn varieties and a package of associated technologies are available in the Philippines. Corn can be grown profitably if yields are 3 times the current national average and marketing is available. The conflicting records of success and failure with yellow corn should be analyzed to determine the best locations for its production. The spotty record of production success with yellow corn is likely a reflection of poor balance between the variety, the cultural practices and the environment. The balance can be improved through additional research and development to match varieties to various environments. Yellow corn will be vital to the enlarging swine and poultry enterprises and will assist the developing beef cattle industry.

Improved varieties of white corn, used mostly for food, are now available and will become increasingly important in view of the rapidly growing population. But the big increase in demand will be for yellow corn for the livestock feed industry. The

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World Bank projects a growth rate of 5.5% per year in the real national income for the Philippines. The income elasticity of corn for feed is estimated at 1.10 (for each 1% increase in real national income, demand for feed corn would increase by 1.10% per capita).

Table 2.2  
Projections of Foodgrain Production, Demand and  
Surpluses/Deficits, Philippines, to Year 2000

	<u>Paddy Rice</u>	<u>Corn</u>	<u>Pulses</u>	<u>All Food Grains</u>
Avg. annual Production 1976-80 (000 mt)	7,043	2,950	52	10,045
Avg. Annual Growth Rate 1961-80 (per cent)	3.81	5.7	2.4	4.31
Projections for year 2000				
Production (000 mt)	12,141	5,624	72	17,838
Area (000 ha)	3,082	3,989	66	7,953
Yield (mt/ha)	4.2	1.41	1.09	2.24
Demand (000 mt)	12,290	7,080	90	21,210
Surplus/deficit	-150	-1,460	-18	-3,370

Source: IFPRI, Assessment of Food/Demand Supply Prospects and Related Strategies for Developing Member Countries of ADB, 1984. Tables 1, 2, 3 and 6.

The IFPRI study cited above projected an increase in production of corn in the Philippines of 90% from the 1976-80 average annual tonnage of 2.95 million metric tons to 5.62 million tons in the year 2000. Demand is expected to be 7.08 million metric tons, leaving a deficit of 1.46 million metric tons. The IFPRI projections assume that corn yields will increase by 2.0% per year and that the area devoted to corn production will increase by 1.1% per year. The area of corn harvested in 1985 was 3,314,000 hectares, about equal to the rice acreage. An increase of 1.1% would require 36,000 hectares.

Both white and yellow corn are susceptible to post-maturity/post-harvest damage. Improvements in post-harvest handling, including storage and transport, are needed to reduce losses and deterioration of quality. Price policies with respect to corn also need study to provide security and stability to buyers from the livestock industry, as well as to corn producers.

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Mung bean: This legume is included because of its value as human food and its acceptability to the population. Adequate yields per year per hectare are possible as a double or triple crop. It is also a very suitable intercrop with sugarcane and other long-duration crops. There is a possibility of over-production, however, if mung bean cultivation is expanded rapidly. The suitability of mung bean foliage, field trash, and processed grain for animal feed should be investigated.

Soybean: The research, testing and development work required to identify suitable varieties and cropping conditions for soybeans in the Philippines have not been completed adequately at this time. However, future or potential prospects for soybean production in the Philippines appear to be good. As an import substitute for animal and human food, soybeans could find an important place in the economy. The fat content is high. Full-fat meal cannot be fed as a high percentage of the diet, so domestic or export markets for oil are needed if this legume is to succeed. Cultivation of the crop requires no special machinery. An oil mill, local or centralized, is required. Soybean field or mill-trash is of value as cattle feed. It is suitable for sugarcane intercropping.

Peanut: This relatively drought-resistant legume is suitable for limited substitution in the Philippines, perhaps only to the extent of domestic consumption. It is best suited to sandy soils because of harvesting problems in heavy soils. It is a high-protein, high-oil crop and, to be viable on a large scale, would require oil export and domestic markets. The foliage is similar to alfalfa in nutritive value for animals. The kernels are highly susceptible to toxigenic post-maturity fungi. Clarified oil is toxin-free. Export of butter or whole nuts would require costly processing. No special machinery is required for production.

Sorghum: This drought-resistant grain crop has failed in some parts of the Philippines but is regarded with respect by farmers in other parts. It is a hardy, relatively trouble-free crop during growth. At maturity, the grains are subject to deterioration by mold in wet weather; this ranges from severe in white-seeded varieties to moderate in red-seeded varieties. Sorghum grain is not widely used as human food but could be an important animal feed constituent.

Cotton: Cotton is now grown in one region of the country and can quite possibly be extended to other regions. It is a rather specialized crop which requires a large amount of pest control, particularly for insects. Lint processing requires that a centralized "gin" be established in the growing area. The Philippines imports a substantial amount of cotton for its textile industry. Since the crop does not require much in imported resources for its production it could be an important saver of foreign exchange.

Cassava: This is a drought-resistant, hardy crop suitable for marginal lands which are not used productively for other crops. Improved varieties are available. It is a high energy food not eaten extensively in the Philippines but an important staple in many countries. It has good potential as a feed for swine and cattle.

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Alfalfa: An expanding livestock industry will create a growing demand for quality forage crops. Alfalfa is an excellent fodder for beef and dairy cattle. Alfalfa leaf meal is a valuable ingredient in poultry feeds. The crops should be suitable for some of the areas with longer dry periods as it is deep rooted and quite drought resistant.

Coffee: Robusta coffee can be grown throughout the Philippines. Yields are quite good. It is a crop well suited to small farms. It should be considered for some of the areas of Negros where sugarcane is now being grown on marginal slopes. The Philippines now imports coffee and could expand production considerably before satisfying domestic requirements.

Pepper: Many areas are well suited to the production of pepper. The Philippines now imports significant amounts but small areas will be able to meet domestic requirements.

Ramie: This is a fiber crop that appears to have good potential. It has been grown successfully on Negros. Careful analysis of the scope of the market, domestic and export, will be required before promoting extensive expansion of this crop.

### 2.5 Export Crop/Product Opportunities

The Philippines exports significant amounts of coconut products and tropical fruits. Climate and soil resources suggest that the country could produce and export more of some of these and other crops at a competitive advantage. Expanding exports of current commodities or launching new export ventures will require careful assessment of the nature of the demand in prospective foreign markets, including prices, competing producers, quality standards, etc. Sophisticated Philippine producers have a basic understanding of markets they now serve, but many prospective producers of new export products have had no experience with the nature and operation of the market systems for alternative products.

Philippine food marketing systems, for various reasons, are much less developed and less efficient than the major Asian metropolitan marketing systems. Fresh produce in the Philippines is largely marketed without grades, standard weights or protective packaging. Handling losses and marketing costs are high. Philippine producers often find it difficult to adjust to what they see as unreasonable demands for quality by Japanese produce buyers. Representatives of prospective Philippine producer groups, packing/processing plant managers and others in the commercial sector involved with new export products will need to learn and experience first hand the conditions of intended markets; merchandising practices, consumers tastes, competitors' product lines, product quality requirements, and the need for high standards in raw materials and product packing, processing and packaging.

In the following paragraphs some of the crops that are thought to have potential for economical production in the sugar growing areas and which can compete in export markets are discussed. For all of these it will be important that their markets be carefully assessed and market and production feasibilities be studied, as they must compete in highly competitive markets, and some of these markets are quite narrow.

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The key to successful commercial ventures and to the ability to obtain conventional financing lies in obtaining reliable numbers and in making credible estimates and projections. For new products in new markets, the procedure is somewhat different. The producer/exporter would conduct appropriately sized market tests at the optimum time of year for the product in cooperation with an interested food importer or broker. Then, estimates are made of the initial size of the market, consumption, projected growth, revenues, and so forth. For example, apparent demand in selected export markets can be determined by examining monthly and annual unload and consumption figures in metropolitan and/or regional markets, and by observing trends in demand over time.

Image enhancement is an essential part of an overall business and trade development program for export products. If not already in place, trade development offices (under the Ministry that handles commerce and/or trade) should be established in key markets not only to promote products but, perhaps more importantly at this stage, to provide market intelligence and reliable numbers to potential Philippine producers and exporters.

With respect to exports in general, Philippine food and beverage products cannot attain a significant import presence in principal Asian/Pacific export markets (Japan, Hong Kong, Singapore, Australia/New Zealand, Soviet Far East) and elsewhere without improvement in the level of sophistication of existing systems for post-harvest handling, storage, transport systems, port operations, and packing/processing facilities. Alternatively, ingenious systems will have to be developed to circumvent the logistics problems and other impediments of local conventional systems. Devising new systems can often be more expeditious than initially correcting existing infrastructural constraints (and there presently appear to be some significant constraints).

Bananas: Fresh bananas have been exported from the Philippines for many years. However, recently Japan has been critical of the quality of Philippine banana exports. The team observed that the quality and varieties available in Manila's top quality markets do not appear to be up to international export standards.

One possibility for rapidly stimulating export banana production and assuring product quality might be for the government to provide economic incentives (such as tax holidays, or favorable financing) in an effort to attract major multinational firms like United Fruit, Del Monte and Dole to organize growers and expand production perhaps using NES schemes. The companies may be interested to construct and operate the packing and shipping facilities and contract with growers to purchase fruit. One key to success for this type of production system is for the fruit packer/marketer to maintain an active grower relations staff to advise the growers in proper husbandry in order to assure consistent quality and production volume. Fruit purchase contracts normally contain a clause whereby the packer is only required to purchase fruit that meets specified quality standards.

Given the large investments that Dole (Dole Philippines, Inc.) and Del Monte (Philippine Packing Corp.) already have in the Philippines, perhaps the government

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might be in a position to exercise some friendly persuasion in order to influence a favorable decision by one of these companies to undertake new plantings or expansion. Both companies are major factors in the international banana trade and have substantial staying power in the marketplace.

Long Fiber Pulp: This is used for the manufacture of linen and other high quality (and high value) papers. Trees which can be grown for this type of pulp are, among others, Eucalyptus, Ipil-Ipil and Poplar. Planted and farmed intensively in hedge-rows (to facilitate mechanical harvesting), and with irrigation, the trees reach harvestable age in about four years in dry areas of the tropics (Hawaii).

Under a scheme, whole trees would be harvested and hauled to a wood chipping plant which could be situated adjacent to a closed sugar mill. The trees would be chipped, followed by air blast separation of wood chips (50-60%) from leaves, branches and twigs (40-45%). The pulp chips would be dried and loaded into containers, or preferably hauled in bulk, for export by barge to Japan and other pulp markets.

The extraneous tree trash could be shredded and dewatered, possibly by passing it through the (modified) former mill train (crusher) and conveying the dewatered trash to the fireroom to be burned in the former sugar factory boiler to generate electricity. This electricity would power the chipping equipment, as well as provide surplus energy for the public utility.

The commercial infrastructure as it presently exists, or with little change, is likely to be adequate for this product scheme. Since the export product is not perishable, there would be no need for significant new port or other facilities from which to ship.

A recent economic feasibility study conducted for private clients showed this concept to be attractive for production in Hawaii to serve domestic markets on the U.S. West Coast. Costs of land, labor, other inputs, and taxes are extremely high in Hawaii, where sugar workers earn an average of U.S. \$100 per day, including \$33 per day in non-taxable fringe benefits. If the production concept is feasible for this location, it would seem logical that it might be substantially more attractive for the Philippines considering also the value of foreign exchange. The returns are sensitive, however, to ocean transportation costs (distances). Therefore, Far East and possibly Australia/New Zealand markets would appear most suitable.

Pineapple: Like sugarcane, pineapple has the advantage of being well-known locally, and is also commonly produced on plantations or with an estate form of agriculture. Of course, the crop is not suitable to all locations, and in any case, a market analysis would be needed to indicate an appropriate scale for additional plantings. Philippine fruit quality is high and of export caliber.

Several alternatives for crop operations are possible. Pineapple can be mono-cropped on sugarlands, or it can be rotated with sugarcane in appropriate climatic areas. This has been the practice in Hawaii for many decades. Since both

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crops are familiar, and yields are higher than normal for both pineapples and sugarcane when rooted, pineapple may be one of the better crop substitution alternatives. An added benefit is the fact that under normal circumstances the first crop (first year) of sugarcane does not require fertilization when planted following a cycle (plant crop plus ratoons) of pineapple.

Although infrastructure requirements for individual products will differ, the discussion which follows for pineapple provides a good example of the kinds of concerns to be addressed when considering investment in commercial export of high value agricultural products.

Pineapples can be exported fresh, canned or processed to juice. Primary export markets would likely be Japan, the Soviet Far East, Hong Kong, Singapore, Australia and New Zealand. The first step is to identify potential markets and determine the mix of products and mode of operations.

To process pineapple, at least one or more fresh fruit packing plants would be required as well as either a cannery or a juice extraction and concentration plant. Product mix will depend on market demand and prices. Normally, farm prices for fresh fruit are more than four times the price of processed fruit.

If fresh fruit is the export product of prime value, then as much as 50-60% of the crop can be packed for fresh shipment, with the balance processed into juice and/or canned. Capital costs for a cannery are considerably higher than for a juice plant although product values may be higher. A new multi-product cannery to process fruit from 15,000 acres would cost about \$30 million if constructed in the United States.

Export of fresh pineapple will require availability of refrigerated surface shipping containers (preferably empty backhaul containers at favorable shipping rates), facilities at a port to handle such containers, and regular outbound shipping schedules. Alternatively, shipment can be by air if prices justify the expense. Here again, airport facilities for handling air cargo (and the containers) must be available. In any case, fresh fruit must be packed and refrigerated within a day after picking. A week to ten days maximum in the container will still allow four days or so of shelf life at retail, allowing 1-2 days for handling and distribution at the broker/wholesaler level.

Pineapple from Luzon now supplies the Manila market. Required conditions such as port facilities, the availability of containers, and commercial shipping schedules may not be adequate on Negros and Panay. Therefore, export fruit may have to be grown on Luzon, and fruit for the Manila market where timing of delivery is less critical be supplied from other islands.

In the case of pineapple, initial merchandising should probably be through private label channels, for both fresh fruit as well as processed products. This should continue until the new producers and packers in the Philippines have established a reputation as dependable suppliers of quality fruit. Quality and dependability are

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absolutely the most important factors in maintaining an export market position. After these are well established, producers could consider establishing their own branded products (with potentially higher margins) in international markets.

Mango: The "Carabao" variety of mango commonly available in the Philippines has an attractive appearance and popular flavor. The flavor is sweet and melon-like, not strangely exotic as are some varieties. It is therefore believed to be a possible product for significant export expansion. These mangoes are also the size usually preferred in developed country (non-ethnic) markets.

The skin however, is thin and scars easily and, when ripe, the fruit is delicate and soft. For significant fresh fruit export market expansion, extremely careful handling will be required in harvesting, transport, post-harvest treatment, and packing in order to maintain consistent high quality standards. Proper atmospheric conditions for extended refrigerated (container) storage will have to be developed.

Fresh fruit will likely be limited to Western Pacific markets including Japan, Soviet Far East (see also discussion under Citrus, below), Hong Kong, Singapore, Australia, and New Zealand. In addition to these, processed products could possibly be considered for Western North American markets (including Alaska and Canada).

Competition from other producers in markets outside the Western Pacific is relatively intense. Mexico exports most of its mangoes to the U.S. and is the largest supplier to the EEC. Various Caribbean Islands are also exporters, and even Peru, Brazil and others in South America have exported fresh and processed products to the EEC. Fruit quality is variable in these countries and most mango production is scattered. Florida production volumes for the U.S. market are also quite variable. India produces large quantities of juice concentrate.

The Philippine variety is somewhat unique, and there is the probability that source identity could be established which could command premium prices. If prices are competitive with other quality fruits (such as pineapple and melons), mangoes could probably find ready acceptance in the developed Pacific markets mentioned above.

In 1981, the Philippines had a total of 42,410 hectares planted to mango orchards, of which about 75 percent were bearing. Production that year totaled 369,864 tonnes. In 1982, production rose 15 percent to 426,278 tonnes. Production in 1983 and 1984 averaged about 375,000 tonnes each year. Demand for Philippine mangoes is reported to be "booming" in Asian markets. However, mango yields are well below the world average, and other Asian nations are taking advantage of the rise in demand for fresh and processed mango and are expanding or, as in the case of Australia, launching new mango production ventures.

Low yields, erratic production levels, and uneven quality of Philippine mangoes are preventing Philippine growers and exporters from what could be consistent profits. In the period 1978-1983, exports increased only 0.6 percent per year. Fresh mango accounts for 90 percent of mango product exports. Only 20 percent of the mangoes produced in the Philippines can pass the specifications for entry into Japan, the Philippines' second largest market and by far the largest potential market.

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The Philippine Chamber of Mango Exporters issued a position paper in June 1985 calling for a wide range of actions for both industry and government. The actions included more accessible credit for growers, improved extension services to upgrade cultural practices, lower freight rates to foreign markets, reduced import restrictions on packaging materials, lower government-mandated export prices to match actual market values in major importing nations, and research to develop alternative post-harvest treatment to replace EDB fumigation for control of fruit flies.

New post-harvest treatment techniques are important because of restrictions in export markets. The U.S. has banned the use of EDB fumigation to treat mango and other tropical fruits. Canada restricted the import of EDB treated fruit in 1984 and Japan restricted the import of Philippine mangoes treated with EDB in 1985. The Japanese government is currently assisting the Philippines in developing a vapor heat process.

While effective extension services can help improve quality, sustained quality fruit production requires grading and price incentives. Growers need to develop good management discipline to maintain a competitive advantage in world markets. In cases where packers are not also growers, packers can provide incentives to growers by sharing with them returns from exports that meet export grade standards. Needless to say, a system of enforced grading standards will be absolutely necessary for any significant expansion of export markets.

While the Western Pacific market characteristics are unknown for frozen processed mango (chunks, slices, halves), the market may not be large. Another product growing rapidly in North American and to some extent European markets is dehydrated fruit - for trail mixes, fruit rolls, breakfast cereal additions, and so forth. Demand for dehydrated mango products in certain selected Western Pacific markets (possibly Soviet Far East, Australia, New Zealand) may exist even though demand is presently low in North American markets due to high prices. India exports prodigious quantities of mango puree and juice concentrate. Poor and widely variable production quality in India provides an agribusiness opportunity for the Philippines if processors could deliver a consistent high quality product. Demand exists in selected markets which could be stimulated through merchandising and dependable product quality. High, consistent quality puree could be exported to North American markets.

Citrus: There are good local as well as export markets for fresh citrus and citrus products. Climate and soil resources suggest that citrus fruits would have good production potential in many areas, particularly in hilly, well drained areas. However, the team learned that past experience in commercial production of oranges has not been good. Repeated efforts to establish orange orchards have been unsuccessful because of disease problems. Until further research develops resistant varieties and/or better management technologies citrus does not seem to be a viable substitute crop.

Significant markets exist if viable citrus production can be established. Most Soviet foodstuffs are delivered long distances from European Russia, West of the Urals, with some from North Korea and elsewhere in Asia. Food is needed to provision ships, but more important to meet demand for food commodities for public markets

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in cities and towns of the region. By Soviet standards, incomes in the SFE tend to be high, with few premium food items available in markets. A wider variety of consumer food goods might decrease turnover in the population of technicians, engineers and other valued project employees. Japan, China and other Asian nations have certain political difficulties in developing regular commercial trade with the SFE, a situation which presents an opportunity in fruit and fruit product exports worth evaluation by the Philippines.

The world market for frozen concentrate orange juice (FCOJ) is expanding. In the U.S., per capita consumption of FCOJ has grown at a rate of 12-13% per year. As U.S. consumption increased, Brazil became the largest and most efficient FCOJ producer in the world exporting over 100,000 tons per year into the U.S. alone.

Competition for the U.S. market, however, has been steadily increasing, with extensive new orchard plantings in the Dominican Republic and Belize, and new ventures being considered for Costa Rica. Therefore, unless the Philippines were granted duty free status into the U.S., as Caribbean countries have been granted, growers could not likely hope to compete with the Caribbean and Latin America. Other Western Pacific markets could be more attractive.

Orange orchards in the U.S. are expensive to establish. Growing an acre of orange trees in southern Florida to commercial volume takes \$7,200 and about eight years. Few businesses so capital intensive have such a long wait for a payout. However, an in-depth study of Western Pacific FCOJ markets together with provision of tax holidays, low interest loans guaranteed against political upset, and other incentives could attract foreign capital as well as stimulate local business interests. For those who can afford the wait, the payout on orange products for North American markets has always been worthwhile. Yields normally reach 200 to 250 boxes per acre annually by the 10th to 12th year, and then keep increasing to 400 boxes in about the 20th year. The trees live for as long as 50 years, assuring a virtual annuity for their owner.

Other product markets, in addition to straight FCOJ, should also be evaluated, particularly juice blends which are increasingly popular in North America. In fact, products such as orange juice blended with guava and/or passion fruit juice may have greater export market potential than FCOJ.

Guava: This crop should be well suited for some of the sloping hill areas. Demand is growing rapidly in North American markets for puree and concentrates for juice blend products, and a market is developing in Japan. Supplies of quality product are primarily from Hawaii, and there is potential competition from CBI countries. The Philippines' potential prime markets would be in the Western Pacific, with perhaps secondary markets in North America. Initial acreage should be relatively limited, while markets are being developed.

### 2.6. Public Policy and Diversification

A wide array of crops has been suggested in this report to potentially substitute for sugarcane in a crop diversification program. Market analysis can help determine the feasibility of each under different conditions for specific locations. The large

## CROP AND PRODUCT DIVERSIFICATION/SUBSTITUTION ALTERNATIVES

planters may be able to plan and implement major adjustments in their cropping patterns, introducing and marketing new crops without much assistance. It will be difficult for some large planters and most small and medium sized planters. Seventy-five percent of sugarcane growers plant less than 10 hectares of cane. Another 13 percent grow only 10 to 20 hectares. Most of them will be too small for private processing plants or irrigation systems and deficient in financial resources and managerial skills to risk new ventures. These growers will need considerable assistance in introducing new crops. It will be particularly difficult in areas that have traditionally had sugarcane mono-culture since commercial facilities to support other crops do not exist.

In sum, it does not appear sufficient to try to implement a diversification program by simply adding funds to existing government programs. The team suggests that the government undertake a more vigorous program with the following elements:

1. In response to the immediate crisis, create a special commission or task force with the two principal objectives: a) to promote and support new ventures by growers (and groups of growers) to diversify the products produced from land currently devoted to sugar; and b) to bring together special community-based task forces to address the problems of communities or regions forced to find alternative crops and products because of the closure of mills. As the team envisions it, this commission would have a temporary life of five years, and would report directly to the President. Appendix C contains a more detailed description of what such a commission might be expected to do.
2. In response to the continuing problem of promoting transition to new productive activities on sugar lands, the team feels it is urgent for the government to consider a range of policy reforms designed to provide incentives to those farmers willing to risk experimentation with products other than sugar.

Opportunities for diversification in sugar production are to a large extent determined by public policies. Macro economic policies determine the money supply, taxation, public spending, local and foreign borrowing and international trade. They affect the level of employment, interest rates, availability of credit, the peso cost of imports and peso value of exports, inflation rate and GNP growth rate.

The government has announced that agriculture and rural areas should lead the way in economic recovery. This could mean improved opportunity for diversification. Past policies of the Philippines have favored food consumers, urban areas and manufacturing. Imports of rice, corn, wheat, beef and soybean meal have, in the past, insured the urban consumers of adequate food at reasonable prices. However, given the overvaluation of the peso, these cheap imports have discriminated against rural domestic producers.

Devaluation of the peso lowers the dollar cost of all goods produced in the Philippines. Currency devaluation is a general economic policy that has the effect of reserving more of the domestic market for domestic producers, while helping to

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capture more of the world market for Philippine workers. Devaluation prices Philippine goods more competitively in the world market. After devaluation, more can be sold both at home and abroad.

Diversification of the sugar industry could also be encouraged by appropriate price policies for grains, especially feed grains and protein. Livestock feed is potentially a large user of land diverted from sugar. Corn or grain sorghum are feasible crop substitutes on most sugar lands. Yellow corn is an intermediate product - an input to commercial livestock raisers and a cash crop to corn growers. The marketplace needs to be stable and secure to serve both sides of the market. Both the price level and security of supply and demand are important. The expansion and efficiency of both livestock producers and corn growers depends on the stability, profitability and predictability of the market. A market stabilization program, with floor and ceiling prices for feed grains, could be administered by the National Food Authority. The lower limit would be defended by government purchases and addition to storage. The upper limit would be defended by release of government stocks and sale on the market of imported grain.

The livestock feed complex for which market stabilization is suggested includes yellow corn, grain sorghum, rice bran, cassava chips and high protein feed like soybean meal, copra meal and Ipil-Ipil leaf meal.

Uncertainty about government policies is an impediment to diversification by many planters. Clarification of the new government's policies could remove risks of land confiscation in the sugar areas and facilitate rational crop substitution. Enunciation of a policy that would encourage voluntary land sharing arrangements could help sugarcane workers produce many of their food requirements.

A decision on redistribution of lands foreclosed by the banks, and lands heavily mortgaged but not yet foreclosed, could be helpful in getting these lands into production in order to provide employment.

An early decision is needed on which sugar mills are to be closed to reduce milling capacity. Areas which will no longer be served by an operating mill will have major crop adjustment problems. These adjustments cannot be made intelligently without sufficient lead time to assess and develop supporting services and infrastructure.

Government policies also need to support a strong research program, including programs that address the problems of adaptation of varieties and technologies to local conditions in areas where crop substitution is feasible.

## CROP AND PRODUCT DIVERSIFICATION/SUBSTITUTION ALTERNATIVES

### Notes

- (1) Gonzales, L. A., Philippine Agricultural Diversification: A Regional Economic Comparative Analysis, 1984.
- (2) The following additional studies are also relevant to Philippine crop diversification:
  - Gonzales, L. A., Towards Greater Efficiency Through Agricultural Import Substitution: The Case of Corn, Cotton, Soybeans and Mung Beans, 1984.
  - Gonzales L. A., Potentials for Crop Diversification in the Bicol Region, 1984.
  - Gonzales, L. A., N. D. Perez, V. B. Marfori, and C. L. Opena, Changing Comparative Advantage of Philippine Soybean Production, 1985.
  - Marfori, V. B., and Gonzales, L. A., A Regional Comparative Advantage Analysis of Sorghum Production in the Philippines, 1984.
- (3) International Food Policy Research Institute, Assessment of Food Demand/Supply Prospects and Related Strategies for Developing Member Countries of ADB (An ADB Supported IFPRI-IRRI Study), Washington, D.C. 1984.

## Chapter Three

### POTENTIAL FOR ENERGY PRODUCTS

Since the rapid escalation of energy prices in the 1970's, the sugar industry has actively investigated opportunities to produce products for energy markets, especially electricity and liquid fuels. This chapter examines the potential for development of three energy products for which the team felt markets in the Philippines exist and for which the technology is either already understood or could be easily adapted to conditions in the Philippines.

Potential to develop energy products does not exist throughout the industry. The team does not believe development of energy products will save the sugar industry in the Philippines from difficult restructuring and contraction. The team does believe sale of energy products can improve the economic performance of the industry, generate additional employment in rural sugar-growing regions, help meet national energy requirements, and possibly provide a market for some cane.

Discussion in this chapter focuses on three potential energy markets which could be exploited by the sugar industry: Boiler fuel, electricity, and alcohol. During the study, the team visited facilities on Luzon, Negros, and Mindanao. The opportunity for boiler fuel appears greatest on Negros where refineries and distilleries currently burn large quantities of wood or imported oil. The opportunity to produce electricity is greatest on Luzon in conjunction with established mills. The opportunity for alcohol depends on the government policy for phasing out lead from gasoline.

#### 3.1. Use of Cane "Trash" for Boiler Fuel

Cane tops and leaves are an available resource at many locations in the Philippines and could be economically substituted for other fuels currently burned in boilers. The team did not attempt to determine the size of the market for boiler fuel. The recommendation to consider the boiler fuel market results from visits to several facilities on the island of Negros where fuel supplies for boilers are either costly or in short supply.

On Negros, where the problems of the sugar industry have had the greatest negative economic impact, the team visited sugar mills, refineries, and distilleries. The crushing season on Negros lasts from five to ten months with the majority of mills operating for six months. (1) Distilleries and refineries often run for longer periods.

Most mills meet their steam and power needs by burning bagasse. However, mills operating distilleries and refineries often cannot produce sufficient steam and power from their bagasse to meet all their needs. These mills usually purchase either electricity or oil or wood or some combination of these three to make up the

## POTENTIAL FOR ENERGY PRODUCTS

difference. For example, the Victorias Milling Company on Negros purchased 150,000 tonnes of fuelwood and 20,000 tonnes of bunker last year in addition to electricity and diesel. (2)

Sugar mills on Negros purchased electricity in 1986 for prices ranging from P1.5-2.0 per kWh (P20.5 = \$1). This price exceeds what it costs mills to generate electricity from bagasse by at least 30%. Oil products used for boilers and generators (bunker, diesel, kerosene) are sold at government-set prices which are considerably above the world market. Prices for wood reported to the team ranged from P280-P450/tonnes and were increasing.

The price of wood on Negros is likely to continue to increase. The team observed extensive deforestation throughout Negros during its tour of the island, which has been reported by several other sources. Wood continues to be cut even at risk of damage to the watershed which supports agriculture on the island.

Given the high costs and increasing demand for wood and oil fuels, the team recommends a detailed study of collection and processing of cane tops and leaves ("trash") left in the fields after harvest. This study can help determine whether supplying fuels to these markets can provide new sources of revenue for the cane industry on Negros. Commercial experience with cane trash collection is limited worldwide. One of the places it has been collected is the Tarlac Mill on Luzon. The Tarlac Mill collected cane trash for several seasons in conjunction with machine harvesting but stopped the practice because the machine cane harvesters were more expensive than harvesting by hand.

Substituting cane trash for wood and oil fuels on Negros will generally stimulate local economies. Of special interest will be the additional income to growers, the increased demand for agricultural labor and the increased business selling and servicing machinery and equipment. Ultimately, decreased use of fuelwood furthers the protection of the watershed on the island.

### 3.1.1. The Resource Base

The sugar plant produces large amounts of fiber in addition to sugar. Each tonne of cane stalks milled yields about one-third tonne of fiber residue (at 50% moisture content) which is called bagasse. When cane is hand harvested green as it is on Negros, additional material is left in the field where it is often burned as a nuisance.

The actual amount of material which is available from cane fields depends on the plant varieties, application of water and fertilizer, and cultivation and harvesting procedures. Information from other locations suggests, however, that the material left in the field can equal or exceed the quantity of bagasse left after milling of the stalks. (3) In the most detailed study conducted to date, a team in the Dominican Republic concluded that on average two-thirds of a tonne of residues were left in the field for every tonne of millable stalks harvested. (4)

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The 10.5 million tonnes of cane harvested on Negros in 1984-1985 would thus have produced approximately 7 million tonnes of residues. A recent study in Thailand estimated that 35% of residues left in the field would be available for energy use. (5) Applying the same percentage for cane grown on Negros yields about 2.3 million tonnes, or 15 times the annual fuelwood demand of the Victorias mill complex.

At harvest, the composition and moisture content of cane trash is similar to bagasse as it leaves the milling train. If left in the fields, the tests in the Dominican Republic showed that the moisture content of the residues could fall from 50% to 30% in 4-6 days.

Of course, it would not be either practical or desirable to collect all of this material. Where and how much cane trash could be collected would depend on terrain, location, the need for moisture retention and weed control, and the need to retain organic matter in the soil. Cane tops and leaves are burned in many places and harvested in some others apparently without decreasing the productivity of the land. Some of this material could be used to displace expensive fuels if collection and processing costs were economically attractive.

### 3.1.2. Harvesting and Delivery of Cane Residues

Few attempts have been made to determine the most appropriate ways to collect and transport cane tops and leaves. Cane tops and leaves are collected commercially by machine in the Dominican Republic as a feedstock for furfural production and manually in India and China for roof thatch and animal feed. In Thailand, some cane trash is hand harvested for animal feed. Transport is by oxcart, truck, and railroad car. These experiences along with the experience at the Tarlac Mill are not always readily transferable to other locations.

Work on cane trash collection is being done to augment the meager data available. The U.S. Agency for International Development has initiated a program to design and test harvesting equipment in conjunction with a project to produce electricity for sale to the grid at the Monymusk Mill in Jamaica. The Government of Puerto Rico has recently announced a program for next year to test techniques for the production and management of high-tonnage cane for combustion in the Aguirre region. Work being carried out at these locations may be relevant to conditions in the Philippines.

Without conclusive results from elsewhere, the Philippines sugar industry would need field trials prior to investment in equipment. Such trials could verify or deny the feasibility of collection and processing of cane trash. One system to be investigated has the following steps:

1. Leaves and tops are allowed to dry in the fields after harvest. Tractor-drawn mechanical rakes pile the material in windrows where it is allowed to dry further for 4-6 days (down to 30% moisture content or less).

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2. Large round baler/compactors (already available commercially) pulled by tractors compact the material into 1/3 tonne bales measuring 1.85 meters in diameter and 1.23 meters in length.
3. The bales are stored outside near the point of harvest. Round bales of this type shed water and will continue to dry during the storage period to as little as 20% moisture. Space requirements preclude storage at the power plant.
4. Bales are transported to the boiler site as needed in the same vehicles and along the same routes currently used for cane.

Observations of the team while in the field suggest this type of system would be workable in the Philippines. The approach would be particularly attractive on Negros where cane is not commonly burned before harvest. Harvesting, loading, storing, and transporting cane trash would generate employment. The acceptable distance between the boiler site and areas where trash could be harvested would of course be determined by transport costs.

The cost for field trash delivered at a mill will depend on the price paid to the farmer, the cost of labor, the cost for necessary field equipment, and the cost for transport. (6) To entice farmers into collecting trash and providing it to mills generating power, incentives such as purchase contracts or price guarantees will be useful. Such incentives could include long term contracts or price guarantees. As collection practices are understood, market forces would set prices.

### 3.1.3. Boiler Modifications Necessary To Burn Bagasse and Cane Trash

Many of the boilers now using oil and wood on Negros were actually designed to burn bagasse. These boilers could easily be modified to burn processed baled field trash.

Before burning in the boiler, baled field trash would need to be broken up. Bale processors or shredder/disintegrators to carry out this task are readily available and would cost about \$3000 (at U.S. prices) per tonne trash per hour capacity plus installation. The boiler site would likely already have equipment capable of moving bales.

Combustion characteristics of cane trash are quite different from those of wood or oil but similar to bagasse. Boilers designed to burn oil will not easily be retrofitted to burn cane trash. Boilers designed to burn solid fuels like wood or bagasse can probably be modified at little cost.

The major differences between the combustion characteristics of bagasse and field trash are moisture content and possibly ash content. Burning field trash at 20-35% moisture content compared to bagasse at 50% moisture content will significantly increase the heat release rate in a boiler and lower excess air requirements leading to higher boiler efficiencies. At the same time, boiler temperatures will increase. Increased boiler temperatures can have adverse effects on grates and refractories

## POTENTIAL FOR ENERGY PRODUCTS

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depending on design especially when fuel has higher ash content. Fine particles or ash can melt and form deposits on heat transfer surfaces or damage grates.

The problems posed by switching fuels for solid-fueled boilers are not insurmountable. The extent of modifications must be determined for each boiler. Simple tests can provide useful data and reduce risk and uncertainty before any major investment.

### 3.2. Use of Cane "Trash" to Generate Electricity

The potential for the sugar industry to obtain revenue from sale of power to the National Power Corporation (NPC) depends on the extent of demand for power, the willingness of NPC to purchase power from the industry, and the cost at which the sugar industry could generate power. The sugar industry may also be able to sell power to private customers.

As an archipelago, the Philippines does not have a continuous national grid. Each of the seven major islands has its own generation, transmission, and distribution systems. However, NPC plans to link the five islands in the Visayas group into one grid in the near future. Table 3.1 gives the NPC installed capacity and gross energy generation for 1980 and 1985 for each of the major islands. (7)

Almost 90% of the power generated on Mindanao came from hydro while 99% of the power generated on Negros came from geothermal and the rest from hydro. New capacity planned on both these islands will not require fuel imports. Although power shortages were reported to the team on Negros, they appear to be problems of the distribution system rather than supply problems. As a result, the team does not recommend that Negros or Mindanao be investigated further for power production by the cane industry at this time. Power generation may in some limited instances be attractive for sale to private customers.

The major market for electricity in the Philippines is Luzon. In 1985, 40% of the electricity on Luzon was generated with oil, 30% with geothermal, 20% with hydro, and 10% with coal. Demand for new capacity was to be met by the nuclear power plant installed at Bataan. At this time, plans to operate this plant have been cancelled. As long as the nuclear plant is not operated, the Luzon system will move toward a shortage of capacity by 1989 at the latest. If the economy picks up more quickly, the shortage will be felt even sooner.

The team concludes that electricity is needed for the Luzon grid and that sugar mills on Luzon could provide power to the grid at costs likely to be lower than other options available to the National Power Corporation (NPC). Power sales would provide employment in regions growing sugar cane, additional income for cane growers, additional electric capacity for the country, and new revenues for the sugar industry. The foreign exchange required to modify sugar mills is small relative to the oil displaced and may be obtainable from private sources.

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Table 3.1  
PHILIPPINES INSTALLED CAPACITY AND ELECTRICITY GENERATION

	1980 Installed Capacity MW	1980 Energy Generated Million kWh	1985 Installed Capacity MW	1985 Energy Generated Million kWh
<u>LUZON</u>	3226	13,115	4101	14,449
<u>VISAYAS</u>	103	321	1343	1343
Cebu	44	178	184	478
Negros	15	35	131	244
Panay	29	84	68	150
Leyte-Samar	3	5	147	441
Bohol	12	19	12	30
<u>MINDANAO</u>	492	1650	907	2965

In Hawaii, the sugar industry initiated electric power production in the early 1970's. As their investment in power equipment has grown, ultimately reaching more than 60% of Kauai's and 40% of the big island's power supply, electricity has become a major product in its own right. Indeed, Hawaiian sugar millers admit that without the revenues from electric power sales, sugar production would have declined sharply by now. (See Section 3.2.3.2.)

The sugar industry in the Philippines may also be able to benefit from the added value electricity sales can bring to the sugar crop. The USAID study in Thailand estimated that production of electricity from cane trash could add as much as 25% to the value of the farming operation and increase milling profits substantially. Similarly, the production of solid fuel from cane trash discussed in Section 3.1 will add value at both the farming and milling ends of the business.

### 3.2.1. Demand and Supply Issues for Negros and the Visayas

Like Luzon, Negros is experiencing the effects of the nation's economic crisis. However, in an essentially one crop economy, the depression in sugar prices has exacerbated the effects of the economic crisis in Negros. Efforts to diversify the

## POTENTIAL FOR ENERGY PRODUCTS

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economy away from sugar have been ineffective thus far. In the electric power sector, the entire system operates on a part time basis, with load factors of less than 25%. (See Figure 3.1) The three sources of electric power are a large geothermal unit, a small hydro station and a small oil-based plant. The oil plant did not operate in 1985. (See Table 3.2)

The hydro plant, at 1.2 MW, provides peak power for the Negros grid. The recently finished (1983) geothermal plant now provides almost all of the baseload capacity. In the past, an oil-fired plant with 11 MW of capacity and a power barge provided virtually all of the power for Negros. In 1981, the oil-fired plant operated at just 32% of its capacity. The 32 MW barge which operated from 1982-1984 had an even lower capacity factor.

Unlike Luzon, there is no imminent shortage of power in Negros. In fact, the island has considerable excess capacity in its geothermal station. Indeed the issue facing Negros is the development of industries to use the power that can already be generated in existing facilities.

The large geothermal unit, originally built to provide power for mines on the island, is underutilized largely because the anticipated demand from the mines never materialized. Not all planned mines were established, while at the same time growing NPA activity forced mine operators to install their own generation.

There are localized power shortages in various parts of Negros. These shortages result from an inadequate transmission system and do not reflect fundamental supply/demand factors. An imminent ADB loan for transmission, including the Panay interconnection, is supposed to eliminate local power shortages.

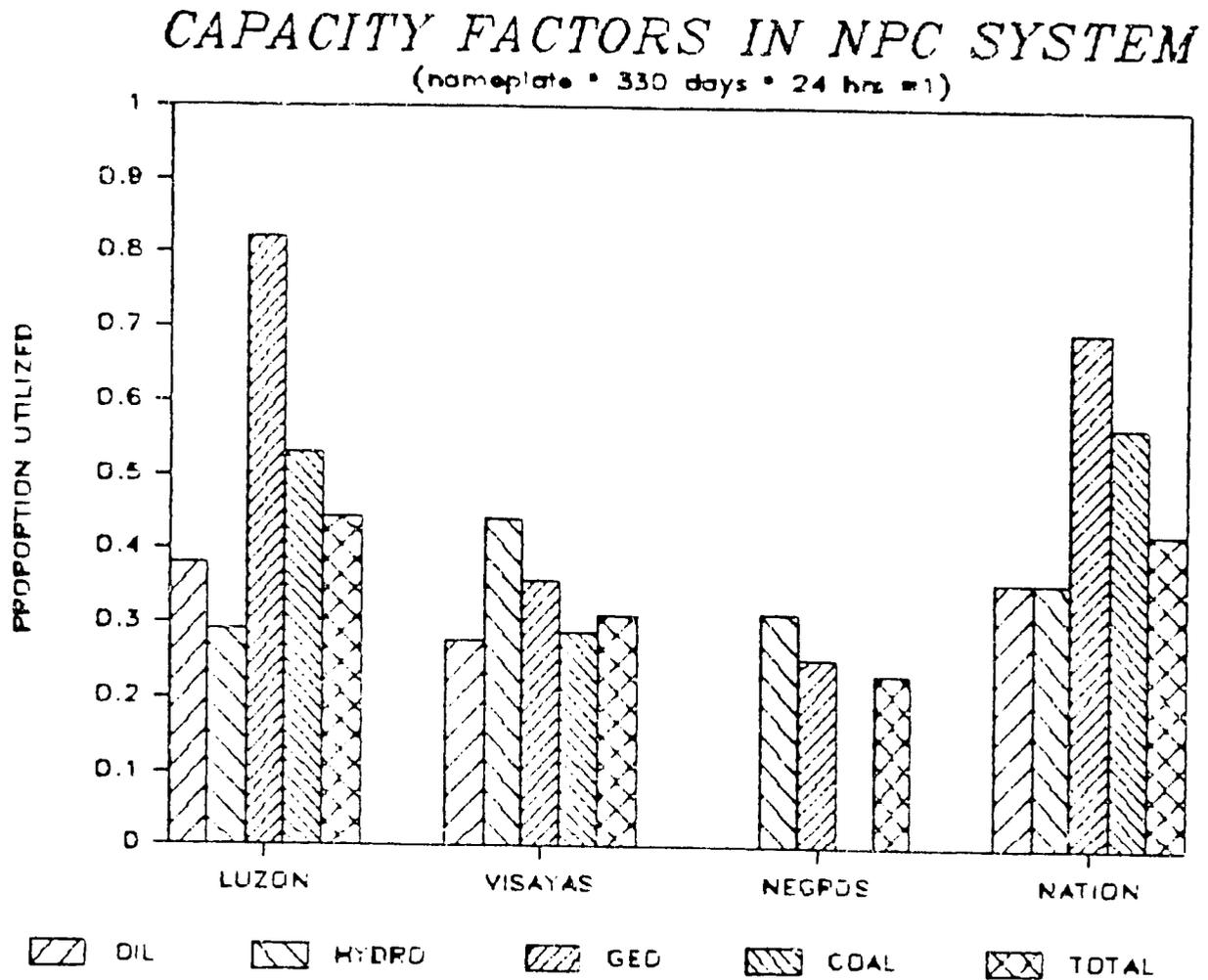
The Panay grid relies on oil power plants for 100% of its electricity. The load factor for the plants on Panay was 47% in 1983. In 1984, the 32 MW power barge was moved from Negros to Panay. Expected growth in demand did not occur which decreased the load factor across all plants to 28% in 1985.

In Cebu, the regional center, over 70% of the capacity is from oil. Even with a recently constructed (1982) coal power plant, more than 75% of the island's power comes from oil. There has been one 32 MW power barge on the Cebu grid since 1985. Once the coal power plant operates at its planned capacity, factor the power barge will only be needed as a peaking unit.

A third oil-fired power barge has been on the Leyte-Samar grid since 1982, although it is hardly used. On those two islands, more than 75% of the capacity is geothermal while oil provides less than 5% of the power generated.

Interconnection between the islands of the Visayas will change the supply and demand issues in the islands. Unlike Negros, the Cebu and Panay grids are heavily reliant on power plants fueled with oil. With interconnection, new sources of power could reduce the need for power barges in the Visayas. However, the availability of existing geothermal capacity and untapped geothermal resources decreases the attractiveness of power generation by the sugar industry.

Figure 3.1



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Table 3.2  
CAPACITY OF NPC'S NEGROS POWER PLANTS  
BASELOAD AND PEAK UNITS (MW)

<u>PLANT TYPE</u>	<u>OIL</u>	<u>GEO THERMAL</u>	<u>COAL</u>	<u>HYDRO</u>	<u>TOTAL</u>
Baseload	0.0	118.5	0.0	1.2	119.7
Peaking	11.0	0.0	0.0	0.0	11.0
Total	11.0	118.5	0.0	1.2	130.7

SOURCE: NPC

Costs of power production vary widely throughout the Visayas. (See Figure 3.2.) In Cebu, coal-fired power is relatively costly at P1.65/kWh. The coal plant suffers from high fuel and capital charges. In Negros, baseload power is reasonably inexpensive, less than P1.00/kWh. Unfortunately, most power is consumed at peak hours on Negros. Consequently, the generation costs jump to P1.50/kWh overall. With peak output dominating the system, the entire cost structure of electricity in Negros appears unfavorable. New baseload capacity, even inexpensive capacity, cannot reduce the peak fuel charges.

### 3.2.2. Demand and Supply Issues for Luzon

The major supply issue for NPC on Luzon is the replacement of the cancelled nuclear capacity. This comes at a time of highly uncertain demand and strained resources. All of the company's expansion plans on Luzon were geared to the reliable output of 620 MW of baseload power starting in 1986. Without the nuclear plant, NPC could have two distinct and unpleasant problems in the next few years.

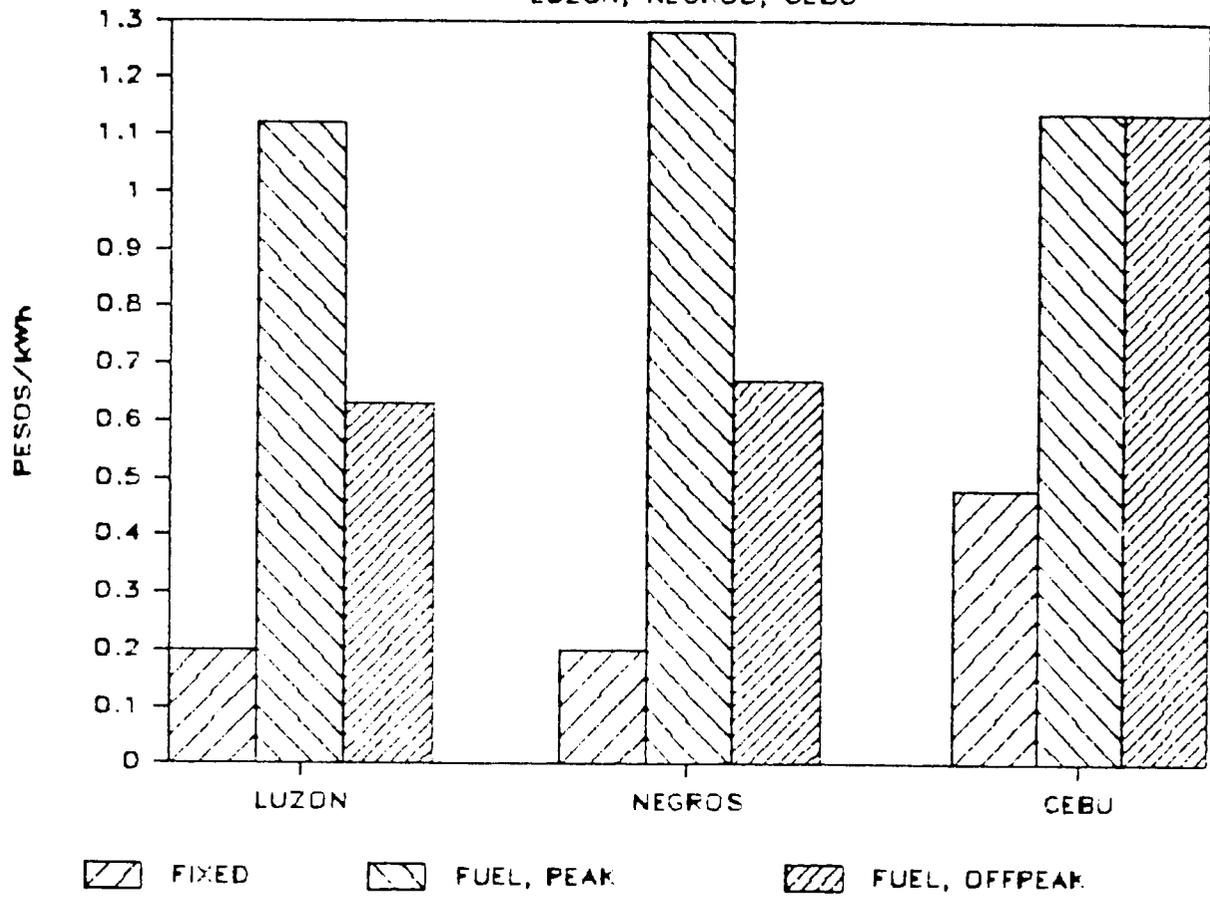
The first problem is the prospect of having to shed baseload and peak demand if the economy picks up. Current reserve margins at 35% are just about the industry standard. With projected demand growth and addition of planned new capacity, the reserve margin will fall to 26% in 1990 and to 14% in 1994. (See Table 3.3) Any delays in constructing new capacity or unanticipated strength in demand will lead to load shedding.

Prior to the economic downturn in the country, MERALCO, serving Metro Manila, experienced regular brownouts. With less industrial output and demand from office air conditioning, overall demand in 1985 fell by 5.5% from its 1983 level. Current forecasts do not predict reaching the 1983 level of demand again until 1988. Thereafter, NPC predicts an increase of 6% annually. Without additional capacity, a return to the 1983 level of demand may mean a return to that year's brownouts.

Figure 3.2

*COST OF POWER PRODUCTION, 1985*

LUZON, NEGROS, CEBU



## POTENTIAL FOR ENERGY PRODUCTS

TABLE 3.3  
LUZON DEMAND TRENDS AND CAPACITY RESERVES, 1986

<u>YEAR</u>	<u>DEPENDABLE CAPACITY*</u>	<u>PEAK DEMAND</u>	<u>RESERVES</u>
1986	3654	2373	1281
1990	3884	2856	1028
1994	4444	3822	624

Source: National Power Corporation, "Cogeneration Potential and Grid Interconnections," January, 1986.

\* Dependable capacity is defined as the total installed capacity of the system minus scheduled service, unplanned outages and variations in seasonal output from hydro. Figures do not include the nuclear reactor at Bataan.

With much of the nation's industrial and financial activity concentrated in the Metro Manila region, load shedding may cause serious economic problems. In particular, industries that rely on continuous processes will install their own power equipment to meet demand at peak time when NPC sheds load. Expenditures for power equipment which will operate only intermittently drives up costs of production.

Loadshedding by NPC may cause more serious secondary problems. If load shedding becomes common, NPC risks defection of industrial customers from the grid due to poor service and high prices. Were this to happen, the power utilities would be faced with the worst of all possible worlds, with their demand increasingly concentrated in the highly peaked and low tariff residential categories.

With the future status of the nuclear plant highly uncertain, NPC must plan to meet the projected level of demand by other means. However, the nation's foreign exchange and investment capital shortages preclude an early recourse to other large projects. As a result, the schedule of planned construction has been pushed back by at least one year from its original targets in the 1984 power plan.

Table 3.4 shows the current capacity of the Luzon system without the nuclear plant and then with it as a part of the expansion plan. There will be no significant additions to capacity until 1992. However, by 1990 even modest demand growth will cut the reserve margin below the one-third level generally considered prudent. The most important aspect of the expansion plan in Table 3.4 is that it represents an optimistic assessment of the time needed to plan and build additional capacity. To meet the schedule, NPC must:

## POTENTIAL FOR ENERGY PRODUCTS

- Start reconditioning the Sucat oil thermal plant immediately.
- Finance the Manito geothermal by 1987 and start construction in 1988.
- Finance the Isabela coal plants by 1987 and start construction in 1988.

None of these projects was envisioned as a substitute for the nuclear plant. However, since the cancellation, NPC stated it intends to speed up the schedule given in Table 3.4. Such large projects require a prior commitment by lenders. The accelerated scenario of NPC does not appear realistic given the requirements of planning, financing and building such plants.

TABLE 3.4  
POWER SUPPLY ON LUZON, 1986

	<u>OIL</u>	<u>GEOTHERMAL</u>	<u>COAL</u>	<u>HYDRO</u>	<u>TOTAL</u>
<u>CAPACITY (MW)</u>					
Baseload	1725	660 <u>1/</u>	300	916	3601
Peaking	200 <u>2/</u>	---	---	300 <u>3/</u>	500
Total	1925	660	300	9166	4101
<u>PLANNED EXPANSION (MW), 1986-1991</u>					
1986					620 <u>4/</u>
1988	100 <u>5/</u>				100
1990		110			110
1992			200		200
1993		23	100		123
1994			300		300
Total <u>6/</u>	100	133	600	--	1453

Sources: 1985 Annual Report, National Power Corporation. A. Gulstone, H. Razavi, World Bank, Personal Communications, 14 July 1986.

Notes:

- 1/ Production varies on a seasonal basis to provide peaking in low season of hydro
- 2/ Converted from baseload, not designed as peaking units
- 3/ Pumped storage
- 4/ Bataan nuclear power plant
- 5/ Renovation of Sucat oil-fired thermal power plant to return plant to nameplate capacity
- 6/ Includes 620 MW of nuclear power at Bataan

## POTENTIAL FOR ENERGY PRODUCTS

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The options which NPC has for meeting its new demand include:

Bringing the nuclear plant online at low power levels. Technically, starting the nuclear plant represents the easiest way to gain the capacity that the grid requires. Whether NPC will be allowed to operate the plant is beyond the scope of this study. However, as long as NPC continues to pay for a plant that it does not use, the company will find the financing of other projects difficult. Current interest charges are \$127.75 million annually. With these funds, NPC could fully amortize more than 950 MW of oil or 650 MW of coal at current world prices.

The NPC's next expansion project on Luzon, rehabilitation of the Sucat oil-fired power plant, was chosen in recognition of the restrictions on capital expenditures. Other planned projects listed in Table 3.4 were developed with the idea that the nuclear plant would be producing revenue for the company. Without it, successful financing of alternative investments becomes more difficult.

Converting the nuclear plant to a coal-fired boiler. Conversion of the nuclear plant to a coal-fired plant is technically feasible, though expensive and arduous. Such a converted plant could not be available to the Luzon grid until the early 1990's. Currently no plans exist to undertake such a project.

More rapid exploitation of geothermal power. More rapid exploitation of geothermal power must be preceded by a stepped-up exploration and development program. Once the resource is better known, additional wells can be drilled and turbines installed. The current geothermal program in Luzon anticipates a decline in output from existing sources through 1990 (NPC Annual Report). Consequently, there is little short-term prospect for increased electricity from geothermal sources.

Increased reliance on small scale power producers. NPC's final option is to meet the demand through increased reliance on purchased power from private producers. The company has already looked at the technical and economic questions surrounding such an option. A study by Stanley Consultants indicates that cogeneration of power from industrial sources is often cost effective and could immediately supply more than 100 MW to Luzon. (8)

The Stanley Consultants report suggests the sugar industry could supply more than 50 MW on Luzon. The team examined the potential and the costs and believes that such production is attractive enough in the near term to warrant more detailed examination.

### 3.2.3. Technical and Economic Considerations for Generation of Power By the Sugar Industry

The results of the team's preliminary investigation show that the island of Luzon meets two criteria for economic generation of power from sugar mills:

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- NPC needs power sources to help meet projected power demands of the late 1980's. Current NPC plans seem designed to return the region to the power shortages and brownouts of the early 1980's. Electricity can be produced from cane residues at costs much less than NPC's current avoided cost of production.
- Cane leaves and tops are available as fuel resources. Field conditions suggest that these residues can be collected economically. Changing the practice in some places of burning cane before harvest would increase the supply of fuel available.

The team did not examine the economic feasibility for specific mills. However, recent work in Thailand and Jamaica indicates that power can be produced by sugar mills at attractive costs. If predicted costs for projects in other locations can be matched in the Philippines, purchase of power from sugar mills can save money for the utility and reduce foreign capital required from the GOP to build new capacity. Based on general review of financially sound mills on Luzon, the team believes power production to be economically and financially attractive. (9)

Existing factory boilers at several large sugar mills on Luzon could be operated during the season when mills are not crushing cane to help meet peak demand. Without major capital expenditure, the team estimates mills on Luzon might provide over 100 MW of peak capacity during the out-of-crop period, more than will be produced by the proposed modernization of the Sucat oil-fired facility. The value of such power equals the avoided energy cost of peak power generation on Luzon. (See Figure 3.2.)

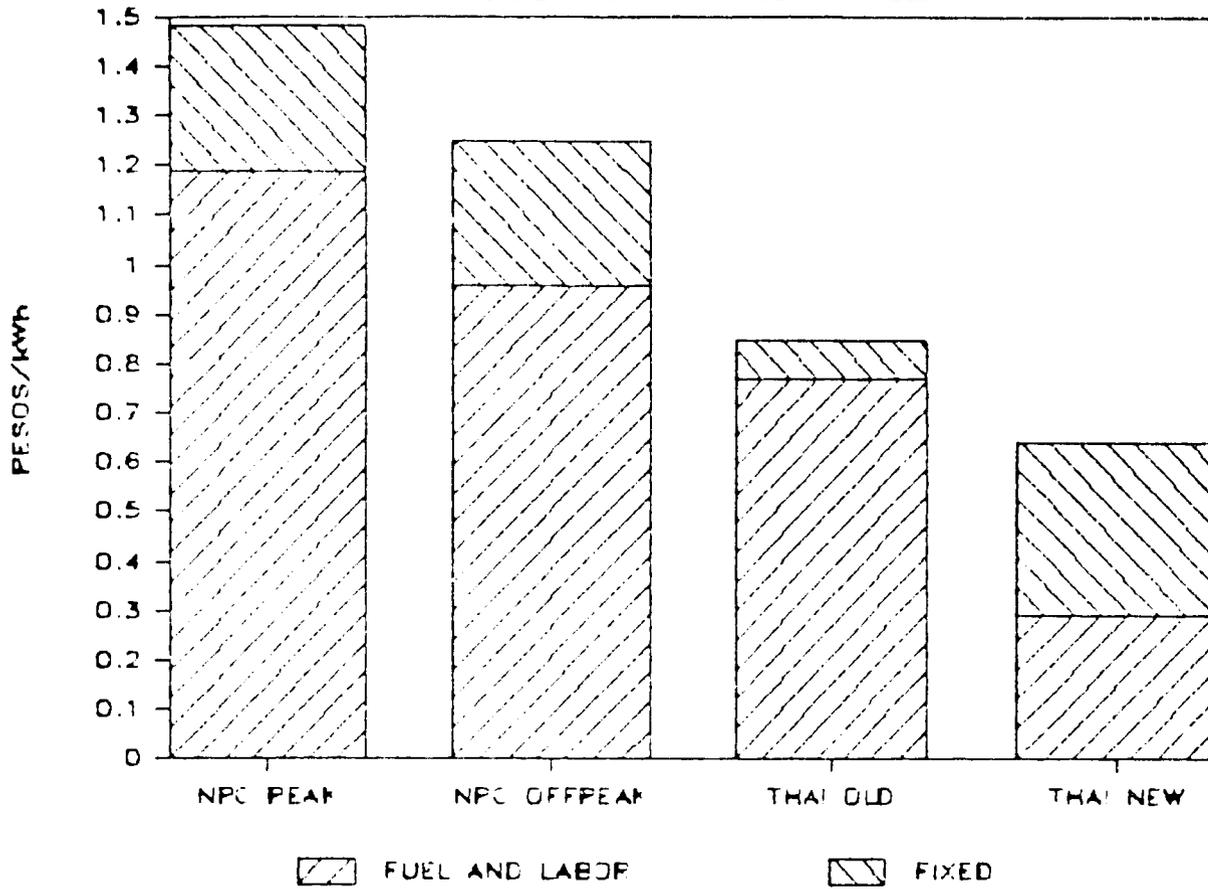
Because the cane crushing season on Luzon lasts about half the year, Luzon mills would need to produce enough power to export during the crushing season in order to provide credible baseload capacity for the system. Some mills could improve their efficiency of bagasse combustion and their level of power production during the milling season without major capital expenditure. But, overall, sugar mills on Luzon need to invest in greatly improved boilers and turbines before they can provide baseload power. To amortize the large investment in new power equipment, NPC would need to agree to buy baseload power and pay a capacity credit.

Sales of power by the sugar industry, whether baseload or peak, increase the value extracted from the sugar plant. From the work in Thailand and Jamaica, the team estimates that sale of baseload electric power will add P80-140/tonne to the value of cane. With new investment, the industry may be able to produce baseload power at less than P1.0/kWh. Capital costs for such new plants will be about the same as for NPC's current baseload plants on Luzon. The fuel costs, however, will be considerably less than those for coal or oil. (See Figure 3.3)

The USAID study in Thailand found that existing mills could return their investments in under three years while new mill investments could pay out in less than five. Assuming investment decisions for the Philippines were made in 1987-1988, plants

Figure 3.3

### COST OF POWER PRODUCTION, 1985 NPC PLANTS V. THAI SUGAR MILLS



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fueled with cane residues could be supplying power to the grid in the early 1990's at a time when NPC has few other options to meet expected demand besides shedding load. The relatively short payback periods for power plant investments indicate that plants can be built without risk that future NPC investment plans will undercut their financial attractiveness.

### 3.2.3.1. Current Power Generation Conditions in the Philippines Sugar Industry

Generation of electricity is not a new concept for the sugar industry. Sugar mills traditionally have provided their own power using residue from the milling operation as fuel for boilers. Most of the energy consumed in a sugar mill is in the form of low-pressure steam. In most plants, steam powers mechanical drives for the crushing and grinding operations as well as providing the heat to process cane into raw sugar. In sugar plants with refineries, large quantities of steam are also used to melt raw sugar for purification. In sugar mills with distilleries, large quantities of steam are used to separate water from alcohols.

Typically, a mill crushing 5,000 tonnes/day will have electric generating capacity of at least 5 MW. In addition, the mill may have considerable standby capacity to preserve certain vital operations during an outage. On Luzon, virtually all of the mills are connected either directly to NPC or to one of the distribution cooperatives. In the Visayas, many of the mills are off the grid and must supply all of their power. In general, sugar mills have not tried to sell power to NPC.

Data collected by the team shows that sugar mills in the Philippines do not currently use steam or generate electricity efficiently. Most boilers are old and operate at low pressures and temperatures. (10) Similar results were reported by consultants to the Asian Development Bank (ADB) in a 1983 study. (11) These consultants estimated average steam consumption at a sugar factory in the Philippines to be 1200 lbs/tonne cane. Efficient modern factories consume less than 950 lbs/tonne cane.

The ADB consultants asserted that excess steam consumption in the remelting and recrystallization of sugar was the main cause of high fuel oil demand across the industry in the Philippines. They suggested improvements in the refining process which could save 400,000 barrels of oil equivalent (boe) annually in refineries alone. (12)

The ADB study reported that bagasse in the Philippines was burned at an average efficiency of 59% compared with 84% for fuel oil. The difference between the efficiencies of combustion of the two fuels is about equal to the volume of fuel oil used annually in the period 1974-1982 (2 million boe per year). Theoretically, an improvement in bagasse utilization could replace all of the fuel oil currently used in the sugar industry. (13)

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Among raw sugar centrals, the apparent efficiency of bagasse utilization varies widely. The mill survey conducted for the current report indicates that some centrals have surplus bagasse while others use large quantities of auxiliary fuels. Some mills have dramatically improved the efficiency of their power plants in the past few years. For example, the Canlubang mill on Luzon greatly reduced their purchase of auxiliary fuels over two years with no significant capital expenditure.

### 3.2.3.2. Potential For Sugar Mills To Generate Surplus Electricity

Power plants associated with the Hawaiian sugar industry first started generating power for sale to the utility in the mid 1970's. Of course, conditions in the sugar industry in Hawaii are different than they are in other countries which produce sugar. In Hawaii, sugar cane is machine-harvested year round after a 24 month growth cycle because of the high cost of labor.

Notwithstanding the unique features of the Hawaiian industry, approximately 15 sugar mills in Hawaii now provide approximately 10 percent of the state's power (63% of the power on Kauai, 40% of the power on Hawaii, 29% of the power on Maui, and 2% of the power on Oahu). (14) Power plants at sugar mills run 24 hours per day and in some cases are the most reliable power plants serving the grid. Revenues from sales of power provide approximately 20 percent of the net revenue to the sugar industry.

In 1983, the sugar industry in Hawaii sold 815 million kWh to the utility and had a nameplate installed capacity of 213 MW. The capacity of the largest plant is 40 MW. The smallest plant has a 2 MW capacity. Six mills have contracts to provide firm power to the grid. Others provide power on an unscheduled basis.

The amount of power that can be produced in association with sugar production depends on the quality of fuel and the basic efficiency of the boiler and generator system. Most sugar mills in the Philippines today rely on low pressure boilers (200-300 psi) to produce steam for mill drives and electricity generation. Steam is exhausted from mill drives and steam turbines at lower pressures and sent to the factory to meet processing needs.

In the past, many sugar mills have considered bagasse more of a nuisance than a resource. The average sugar mill produces only 10-20 kWh per tonne of cane processed, generally enough to meet mill and factory demands. In a surprising number of cases, sugar mills are forced to import large amounts of electricity from the grid to supplement the power they produce.

As demonstrated in Hawaii, it is possible to dramatically increase the amount of electricity produced in association with sugar operations. The more efficient Hawaiian mills produce some 70 kWh per tonne of cane. Hawaiian mills use high-pressure boilers (from 800-1250 psi) and separate sugar operations from power generation to enable power production to continue even if the mill or factory shut down. The power plant provides all process steam needed for sugar processing.

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To help examine the potential for the global sugar industry to produce electricity, AID's Cane Energy Assessment Program developed a model to predict the quantity of electricity that could be produced by an efficient sugar operation using an 865 psi boiler and modern turbo-generator equipment. (15) By using input parameters for a particular situation, the model predicts the technical and economic performance of a mill producing multiple products. For example, a hypothetical mill with efficient equipment grinding 4600 tonnes per day working 44 weeks per year could expect, after satisfying its own needs for electricity, to export an average of 10.5 MW of electricity. At \$0.09/kWh, the revenues from electricity would equal \$7.5 million annually.

If sugar mills add cane tops and leaves collected from fields after harvest to bagasse as discussed earlier, the quantity of electricity that could be produced jumps. For the hypothetical mill discussed above, adding 0.25 tonnes of cane tops and leaves to bagasse would increase the electricity produced per tonne of cane stalks processed to 200 kWh. The mill would be able to export an average of 27.5 MW to the grid and obtain revenues of \$19.6 million annually.

### 3.2.3.3. Opportunities for the Philippine Sugar Industry To Sell Surplus Power

The potential market for surplus power from the sugar industry varies widely from one region to another. At this time, power shortages only appear to be a problem on Luzon. Until the nation's economy picks up, the power shortages on Luzon will be limited to peak demand periods. However, an economic recovery could leave Luzon with baseload capacity shortages by 1990-1991. Investment decisions made by 1988 would lead to plants able to deliver power at that time.

On Luzon, much of the crop is burned prior to harvest and the efficiency of energy use in the industry is generally low. Consequently, a discussion of the possibilities for electricity production must assume certain changes in field practices and improvements in mill efficiency. Less burning of the crop can be induced by changing the incentives for cutters. In Thailand, for example, burned cane receives a substantially lower price than green cane.

Many of the Philippine mills rely on very old boilers. Replacing such units is desirable if the outside electricity sales can pay for the energy savings. The team found that new boilers and generators offer attractive rates of return at electricity prices well below the current wholesale levels in the Philippines.

Section 3.1 suggested ways in which cane trash could be collected to be used as fuel for power plants. Recent work in Jamaica suggests costs for collection of trash will fall in the range of \$8-14/MT (about \$4-7 boe).

Changes necessary to make electricity production a feasible alternative with existing equipment are relatively minor. A study prepared for AID in Thailand found that relatively simple, low cost modifications of existing equipment could reduce the

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heat rate for electricity in existing boilers from 45,000-50,000 BTU/kWh to the 35,000-40,000 range. The major changes include reduced turbine backpressure and improvements to the boiler's performance. (16)

The entire power output from a modified unit could be delivered to the grid for 175-200 days, the period when sugar mills in the Philippines are not grinding cane. Only relatively small amounts of power would be available during the crushing season.

In mills with efficient boilers, the retrofits required to produce commercial quantities of electricity during the off-season are small. They range from about P0.03-0.06/kWh. The only equipment purchases needed are fuel handling and processing systems for the cane trash and improved synchronization equipment for feeding the power into the grid. Figure 3.3 shows the breakdown of electricity costs by fixed and variable rates for the NPC and also shows the estimated values for two Thai sugar mills. The first Thai mill, with existing boilers and turbo generators, would produce baseload power for less than the NPC offpeak fuel charge of P0.95/kWh. A new unit with high efficiency boilers and generators should produce power in Thailand at an equivalent of P0.65-0.70/kWh.

Using the existing capacity of all the mills currently operating on Luzon would produce more than 130 MW of capacity additions for the Luzon system from the sugar industry during the off-season. An additional 100-150 MW is available for the whole year with investment in new boiler and generator units.

Before any definitive answers can be given on the desirability of using sugar mills to contribute to Luzon's power supply, several issues need to be investigated more closely. These issues are:

- the receptiveness of the NPC to large volumes of private power;
- cane trash harvest costs and required changes in agronomic and harvest practices;
- financial support for equipment purchases from external donor agencies or banks.

NPC has indicated a willingness to discuss power generation by the sugar industry. Modified existing units could be used to meet peak and intermediate loads since their capital costs are low per unit of output. Investments in new efficient power generation equipment can probably only be justified if units operate as baseload plants. In the Thailand case, the authors found that upgraded plants needed to operate at a load factor of at least 50% before they were economic.

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### 3.3. Production of Fuel Alcohol

The most-publicized alternative to sugar production for the sugar industry has been the fermentation of sugar (cane juice, high-test molasses or final molasses) to ethanol. Anhydrous (dry) ethanol can be blended with gasoline for use in conventional automobiles or hydrous (wet) ethanol can be used alone in specially-adapted spark ignition engines.

Brazil, which now produces over 11 billion liters per year of fuel alcohol, has demonstrated the feasibility of both approaches. Experience in the U.S., which produces over 2.5 billion liters/year, has also proven the octane enhancement properties of ethanol when blended with gasoline up to 10%. Mandated reductions in gasoline lead content in the U.S. (from 0.29 to 0.03 g/l) have boosted the demand for ethanol in spite of a dramatic reduction in the price of oil. Some 20 countries now produce alcohol for use as an automotive fuel and over the past seven years, worldwide ethanol production has increased more than seven fold.

The economics of alcohol fuel production, however, are highly sensitive to world oil prices and must be evaluated on a case-by-case basis. With current low oil prices, new facilities which produce alcohol from sugarcane will not be attractive without subsidies. Decisions concerning alcohol must examine the economic costs and benefits associated with sugar industry employment, oil import displacement, lead displacement in gasoline, and alcohol-based by-products (animal feeds).

In the Philippines, the future of alcohol development is uncertain at this time. GOP mandates for lead reduction and alcohol blending with gasoline will be important stimuli to alcohol production from cane. At current oil prices, however, alcohol from cane cannot be a profitable enterprise in the Philippines in the absence of subsidies. A task force from the Minister of Trade and Industry has studied costs and benefits and has recommended a subsidized alcohol program to displace lead.

Prospects for alcohol exports are poor at current world oil prices. Nevertheless, at current world sugar and oil prices, sugar is worth more as alcohol than it is as sugar.

#### 3.3.1. History of Alcohol Fuels Development in the Philippines

The Philippines has made several attempts to build a domestic ethanol industry to supply fuel for automobiles. The "Alcogas" program, which took place in the mid-1970's in Negros and Panay, was limited to mixing locally produced hydrous ethanol with regular gasoline from the PNOC refinery in Bataan. At the time, Japan strongly encouraged production of beverage or chemical grade alcohol throughout Southeast Asia.

The Philippines program, however, did not take steps to prevent water contamination or phase separation and did not modify the gasoline to account for the volatility of ethanol. Consequently, vehicle owners reported numerous cases of

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vapor lock. Vapor lock and alcohol's tendency to attract water pose problems for transport, storage and use in engines. These problems, however, can be effectively controlled.

The second program, in 1983, planned to upgrade five annexed molasses distilleries to produce 50 million liters of 95% ethanol annually. At the same time, five new annexed distilleries and two autonomous distilleries would be built to produce another 97.5 million liters of 95% ethanol. The roughly 150 million liters of ethanol would be sufficient to displace tetraethyl lead in gasoline throughout the Philippines.

The Philippine government, under decree 2201 by former President Marcos, formally announced the institution of a national alcohol program in 1985 which expanded the 1983 plan. The new program called for rapid construction of distillery capacity to achieve a production level of 600 million l/yr of anhydrous alcohol, of which half would be exported (ostensibly to Japan). The decree called for creation of an Alcohol Corporation to oversee the program and possibly to operate new alcohol distilleries in the country. At least three new distillery contracts were signed before the change in administration.

Under the Aquino administration, the alcohol program was remanded for evaluation to a task force supervised by the Ministry of Trade and Industry (MTI). Both MTI and World Bank evaluations rejected the prospects for an export market for Philippine alcohol and have, instead, recommended a more limited program aimed at the domestic substitution of ethanol for tetraethyl lead in gasoline. (18)

- Phase I, 1987: Produce 43 million liters of fuel ethanol using existing capacity. Establish 10% blends in Regions 5-12 (all islands south of Luzon).
- Phase II, 1988: Add capacity through distillery renovations and new annexed distilleries to produce 100 million liters of fuel ethanol. Begin 5% blends in Regions 3, 4, and Manila.
- Phase III, 1989: Further expansion of capacity through annexed distilleries to produce 150 million liters per year. Institute 10% ethanol blends nationwide.

Legislation already exists in the Philippines which mandates phasedown of lead additives. The level of lead in the air in Manila is 0.68 milligrams per cubic meter which is 30 times higher than the Philippine standard. There are other products available to displace lead such as MTBE from natural gas which are currently less expensive than alcohol. Any of these products would need to be imported.

Several distilleries are already in operation. A relatively large distillery (210,000 l/day) was constructed by Asian Alcohol Corp. in Negros to produce anhydrous

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alcohol for fuel blending. In anticipation of the widespread introduction of alcohol fuels, several smaller distilleries installed dehydration columns (Victorias Milling Co., Destileria de Tarlac).

### 3.3.2 Alcohol Cost/Benefit Issues

The two principal motivations for the alcohol program approved by MTI are the continued severe depression in the sugar industry and concern over lead contamination in urban areas. Of the 200,000 Ha of sugar lands now idled by declines in sugar demand, 55,000 Ha could be put back into production by instituting the program and 100,000 jobs would be created. Displacement of tetraethyl lead imports by ethanol will also save the country P400 million (approx. \$20 million) annually.

Alcohol currently costs substantially more to produce than gasoline. Philippine alcohol producers claim a price of P7/l (34¢/l) is necessary to produce alcohol from "A-strike" (or "high-test") molasses costing P1200/tonne. (19) Eventually, cane juice will be the preferred feedstock. The Sugar Regulatory Administration has guaranteed that efficiency improvements will allow the alcohol price to be reduced to P6.50/l by 1989, as evidence of the importance the industry attaches to the implementation of the program.

The MTI Task Force recommends the GOP subsidize ethanol blends to maintain pump prices for gasoline at current levels. The subsidy takes two forms, foregone taxes and consumer subsidy. With oil at \$15/bbl., the cost of foregone taxes is estimated to be P400 million/year (net of P67 million in new taxes that will be generated by the program). The consumer subsidy to maintain pump prices will cost P87 million/year. At current oil prices, the losses in government revenues are partially offset by savings in foreign exchange from reduced petroleum product imports.

MTI computed the Economic Internal Rate of Return of the alcohol program to be 11.69 percent. Health and other social benefits were not included in the analysis as they are difficult to quantify. The program's Domestic Resource Cost of 1.1 indicates the relative efficiency of alcohol production in saving foreign exchange. Approval of the alcohol program by the full cabinet and President Aquino was expected by November 30, with program implementation to begin on January 1, 1987.

Reviews of alcohol fuel potential and programs in the Philippines by the Asian Development Bank and World Bank over the past three years have raised questions concerning the timing, feasibility and economics of new distillery construction. Specifically, the World Bank and many Filipinos feel that alcohol development should be financed by private investments, rather than through a government directed implementation timetable. At the price of P7/l set for ethanol produced from A-molasses, the incentives to prompt sugar companies to invest in new distilleries may be insufficient.

The World Bank and some Filipinos also question the need for a consumer subsidy. If alcohol costs were passed along to consumers, gasoline prices would rise about 20 centavos (\$0.01) per liter and still be much lower than prices of the recent past.

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### 3.3.3. Effect of By-Product Sales on Alcohol Production

The economics of alcohol production could be improved by using distillery by-products. Many Filipino distilleries already recover yeast and carbon dioxide for sale. In addition, the Destilaria de Tarlac has developed an anaerobic digestion system that, when expanded to full capacity, will produce enough methane to meet all of the distillery's energy requirements. Potential by-product credits are summarized in Table 3.5. (20) In total it may be possible to achieve as much as \$0.10/l in by-product credits with technology that is either commercial now or that is likely to be commercial within the next 3-5 years. If alcohol is worth \$0.34/l, by-product credits can potentially increase distillery revenues by as much as 30% in the near term.

Table 3.5  
Potential Distillery By-Product Credits

	Quantity Produced (kg/liter)	By-Product Value (¢/kg)	Cost of Recovery (¢/kg)	Net Credit (¢/liter)
Yeast (from fermentation)	0.04-0.08	33.0	11.0	0.87-1.74
Carbon Dioxide	0.55	15.4	6.6-8.8	3.63-4.84
Bagasse	0-0.26	8.4	0	0-2.29
Stillage	0.72 (organics)	nil	-3-0 <sup>1</sup>	-3 <sup>1</sup> -nil <sup>2</sup>
Methane from stillage	80 liters/liter	0.014 ¢/liter	0.007¢/liter	0.58
Yeast from stillage	0.15-0.25	33.0	12.5	3.08- 5.1
Algae from stillage	0.5-1.5 <sup>3</sup>	(34.0) <sup>4</sup>	8.3 - 24.9	

1 Cost of stillage treatment in aeration lagoons.

2 A slight benefit can be achieved using stillage in "ferti-irrigation" if an irrigation system already exists.

3 Theoretical upper limit

4 Cost based on theory. No commercial systems in operation.

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### Notes

- (1) Data from Philippine Sugar Commission, "Annual Synopsis of Factory Performance Data Crop Year 1984-1985," Quezon City, Philippines, 1986.
- (2) The team with the help of the Philippine Sugar Commission distributed a questionnaire to a number of sugar mills on Luzon and Negros. The data presented on Victorias Milling Company is taken from their response to the questionnaire. Throughout this chapter, tonnes represents metric tons.
- (3) The productive capacity of the cane plant is discussed in detail in Alex Alexander, The Energy Cane Alternative (New York: Elsevier), 1985. Tests conducted by Alexander and his associates at the University of Puerto Rico, which measured the amount of dry matter in machine-harvested cane stalks, concluded that for each tonne of stalks, there was an associated 0.85 tonne of tops and leaves. Barney Eiland and others at USDA in Florida in "Unburned and Burned Sugarcane Harvesting in Florida," Transactions of the ASAE (Vol. 26, No. 5, 1983) discuss quantities of trash left in the field after burning and mechanical harvesting. Extrapolating from their estimates suggests that for each tonne of stalks, there was an associated 0.5 tonne of tops and leaves.
- (4) The electric utility in the Dominican Republic sponsored a study to determine the feasibility of a power plant fueled by cane trash. For details, see Republica Dominicana, Corporacion Dominicana de Electricidad, "Estudio de cuantificacion, recogida, acopio, manipulacion, transporte y almacenamiento del barbojo en los ingenios Barahona, Consuelo y Quisqueya; Informe Final" (Santo Domingo: DCE, 1983). For further details, see "Cane Crop Residue fo Biomass Fuel," by Allan Phillips available at the Department of Agricultural Engineering, University of Puerto Rico, Mayaguez.
- (5) Estimates of how much of the cane trash left in the field after harvest can be collected given the role of trash in water retention, weed suppression, and soil fertility are discussed in detail in the resource base chapter of USAID, "Electric Power From Cane Residues In Thailand," Washington D.C., September 1986, pp. 15-22. The chapter also discusses the effect of the spatial distribution of fields and several other important factors.
- (6) Ibid.
- (7) Data presented in this section is from the National Power Corporation 1985 Annual Report.
- (8) Stanley Consultants, "Cogeneration Potential and Grid Interconnections," Ministry of Energy Bureau of Energy Development, Nonconventional Resources Division, Philippines, January 1986.

## POTENTIAL FOR ENERGY PRODUCTS

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- (9) Because of low world sugar prices in recent years and high costs to repay investment capital, a number of mills in the Philippines have been taken over by the banks holding their loans. The future of these mills depends on the results of negotiations between the Government of the Philippines and the World Bank on how to restructure the sector.
- (10) The team surveyed ten sugar mills located on Luzon and Negros. For this survey, each mill provided the age and design details of its installed boilers.
- (11) The primary focus of the Syner-Tech, Inc. report, "Philippines Bagasse Utilization," (Asian Development Bank, 1983) was the potential to improve performance of existing sugar mill processes.
- (12) Ibid, p. 54.
- (13) Ibid, pp. 41-43.
- (14) Data on the Hawaiian sugar industry throughout this section was provided by Charles Kinoshita of the Hawaiian Sugar Producers Association.
- (15) Stephen Clarke and William Keenlside from the Audubon Sugar Institute at Louisiana State University (LSU) developed a computer model to predict the production and value of sugar and/or molasses and/or ethanol and/or electricity using alternative milling, processing and steam conditions. Bechtel Corporation modeled a modern steam plant optimized for use by the sugar industry and integrated their model with the LSU work. Both models are available from the Cane Energy Assessment Program, AID Office of Energy, Washington, D.C. 20523, and can be used to estimate technical and economic performance of sugar mills producing multiple products under varying conditions.
- (16) Details of the modifications needed to improve efficiency at existing mills and allow them to burn cane trash are detailed in USAID, "Electric Power from Cane Residues in Thailand," Washington D.C., September 1986.
- (17) William Klausmeier, "Worldwide Review of Biomass-Based Ethanol Activities," Final Report to Meridian Corporation by Jayco:, Alexandria, Virginia, April, 1985.
- (18) The team assessment of planned alcohol activities is based on conversations in the Philippines and private communications.
- (19) Patrick C. Parsons, "The Fuel Alcohol Program and Philippine Sugar Policy in 1986," Asian Alcohol Corporation, Manila, May 1986.
- (20) The information in Table 3.5 is based on analysis of alcohol by-products in USAID, "Fuel Alcohol Production in Honduras," Washington, DC, May 1986, and on market data collected by the team in the Philippines.



## Chapter Four

### FEED PRODUCTION OPTIONS FOR THE PHILIPPINE SUGAR INDUSTRY

The production of animal feeds from local sources represents an important new commercial opportunity for the Philippine sugar industry. Chapter 2 addressed some feed crops (alfalfa, corn), which could be planted on sugarcane lands in place of cane, as well as prospects for development of an improved feeder calf industry for beef cattle. This chapter examines the Philippine animal feed industry and markets, the technologies for producing feeds directly from sugarcane and from sugar industry by-products, and the potential to apply these technologies in the Philippines. The chapter closes by discussing strategies for introducing technologies of merit.

The Philippines currently imports most of its animal feed ingredients, particularly the expensive protein components. The market examination in this chapter reviews the current status of the livestock, poultry and feeds industries. The technology section then reviews the types of system, both commercial and emerging, for producing feed protein and fodder from molasses, cane juice and bagasse wastes. It emphasizes those options that can be implemented using existing facilities in the Philippine sugar industry. The evaluation of potential applications in the Philippines includes a preliminary cost analysis to help identify feasible approaches.

#### 4.1 Animal and Feed Markets

##### 4.1.1 Status of Livestock, Poultry and Fishery Industries

The livestock, poultry and fishery industries contribute an average of 29.3% to the gross value added in the agriculture sector (which also includes forestry -- Villegas, et al., 1985). Hogs, poultry, cattle and carabaos, in that order, account for most of the country's supply of meat products, with goat production experiencing recent expansion in response to strong demand from the Middle East. There is currently a ban on the slaughter of carabaos because of their importance as draft animals.

The production of hogs and chickens has slowly increased over recent years, with chicken production growing somewhat faster than hog. There is a trend towards greater commercial production of hogs and chickens (as well as goats). From 1970 to 1983, the percentage of hogs produced commercially grew from 10% to 36% of total hog production, and the commercial production of chickens grew from 19% to 37%. Increased commercial production of hogs, chickens and goats probably reflects the lower space and investment requirements, and the higher reproductive and feed-to-protein conversion rates they have when compared to cattle.

Although the trend is still up, increasing feed and drug/biologics prices combined with inflation and internal problems disrupted hog, chicken and goat production in recent years. Competition, high feed prices and turbulent markets forced numerous small independent producers out of business, and reduced animal populations in some

## FEED PRODUCTION OPTIONS

cases (e.g., poultry operations by 5% in 1984). Historical data on livestock and poultry populations is summarized in Table 4.1. Historical and projected trends in meat production are summarized in Table 4.2.

Table 4.1  
Livestock and Poultry Population  
(000's of head)

	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>
Cattle	1,805	1,824	1,921	1,942	1,938	1,849
Carabao	2,803	2,870	2,783	2,908	2,946	3,022
Hogs	7,445	7,934	7,556	7,953	7,980	7,613
Goats	1,424	1,640	1,698	1,783	1,859	2,362
Chickens	49,320	52,7614	56,275	59,710	62,255	59,2053

Source: Philippine Bureau of Agricultural Economics

Cattle production, by contrast, has stagnated for many years and has even declined recently for a variety of reasons. These include an insufficient breeding base, lack of incentive to produce high quality beef, and the lack and high cost of prepared feeds. The Philippines imports beef, and there is a clear need in the domestic market for an expanded fed-cattle industry.

Livestock production is primarily a "backyard" industry, accounting for 75% of cattle and 95% of carabao production in 1983. Feeding is generally haphazard with heavy reliance on forage and little use of concentrated feeds. Domestically produced meat quality is poor and nearly all imports are higher grades. Beef imports in 1983 totalled 7,159 MT, or about 6% of domestic production, and were worth almost \$20 million. Furthermore, milk production in dairy cattle is poor and domestic production cannot compete with low cost dairy product imports, which totalled 105,830 MT in 1983.

Fish and other marine animals are the principal sources of protein for the population of the Philippines. Estimated per capita fish consumption is 30 kg per year (compared to approximately 18 kg of meats) for a total annual fish consumption rate exceeding 1.3 million MT (Robinson, 1985). It is difficult to accurately document total fish production and consumption since it is largely a local enterprise. Import/export data, however, is readily available (Table 4.3), and it shows that the value of marine product exports has increased steadily, exceeding the value of imports since 1977. Marine product exports declined 25% in 1984, however, totaling

Table 4.2  
Trends in Meat Production  
(in thousands of metric tons)

<u>Product</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	*	<u>1985</u>	<u>1986(est)</u>	<u>1987(est)</u>
Beef/Carabeef	110.2	99.1	110.9	107.3	119.7		136.33	142.68	149.31
Pork	436.7	491.2	441.2	430.3	471.0		382.58	400.09	418.39
Poultry	133.3	143.1	147.3	151.8	154.2		223.90	233.87	244.28
Chevon	8.7	9.6	10.3	11.5	12.9		33.62	35.14	36.73
Eggs							170.02	177.59	185.57
Milk							1244.65	1298.79	1355.29

\*1984 Data not available

Sources: Policy Analysis Staff, Philippine Ministry of Agriculture and Food; and M. Mosqueda-Velasco, Livestock Policy Choices: The Philippine Experience, Bureau of Animal Industry.

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57,999 MT (compared to 76,300/MT in 1983). This decline is attributed to a tight dollar supply and changes in export policies which adversely affected the canning industry. (PFDA, 1985)

Table 4.3  
Imports & Exports of Marine Products  
(US\$ million, FOB)

	<u>1970</u>	<u>1975</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>
Imports	16.6	33.4	19.7	26.5	29.5	38.1	6.8
Exports	4.0	16.7	94.4	138.2	143.3	119.3	131.6

Sources: Food Processing Sector Report, World Bank, 1985, and Foreign Trade Statistics, Philippine National Census & Statistics Office

Much of the recent increase in fish production can be attributed to aquaculture of milkfish and tilapia in fishponds. In 1980, 176,000 Ha of ponds produced 136,000 MT of fish (Leeds, 1984). Aquaculture currently accounts for 25% of total fish production in the Philippines, and an estimated 375,100 Ha of additional swampland is considered suitable for commercial development. As in Thailand, Ecuador, Honduras and a number of other countries, continued aquaculture industry expansion presents a promising development opportunity for the Philippines.

One of the most promising aquaculture areas is the production of shrimp. Penacid shrimp (the principal class of marine shrimp) landings have declined over 10% in recent years, from 19,368 MT in 1977 to 17,244 MT in 1981. By contrast, shrimp exports more than doubled from 2,349 MT in 1977 to approximately 5,000 MT in 1984, and currently generate \$21 million in export earnings (PFDA, 1985; Leeds, 1984). The Philippines now produces about 2,000 MT/yr of Black Tiger prawns by aquaculture for the Japanese market with production growing at an annual rate of 20-50%. The most optimistic projections suggest that shrimp farming in the Philippines could reach 300,000 MT annually by the end of the century (Mock, 1984).

Much shrimp aquaculture is conducted by small farmers in operations of 5-20 Ha, and industry expansion should continue to provide opportunities at this scale. Nevertheless, large-scale corporate shrimp operations have production cost advantages, and are in a better position to acquire the feed production and hatchery technology needed for large-scale expansion of the industry.

Perhaps the largest constraints to the growth of fish and shrimp aquaculture in the Philippines are the shortage and high cost of feeds necessary for these intensive operations. Both large and small producers are currently experiencing a severe

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shortage of quality feed because of limitations on the imports of fish meal and soybean meal feed components. Furthermore, feed costs comprise up to 70% of the cost of shrimp production. The development of local sources of protein to substitute for imported ingredients in aquaculture feeds would be a major step in promoting the continued development of this industry.

### 4.1.2 Status of Feed Milling Industries

There were 121 commercial feed mills registered in the Philippines as of July 31, 1982, with 89 of those mills located on the island of Luzon. The aggregate capacity of these mills is just under 30 million 50-kg bags/year (Villegas et al., 1985). Historical data on commercial feed sales in the Philippines is summarized in Table 4.4.

Hog and poultry feeds represented 98% of all feeds produced in 1983. Aquaculture feed production has only become significant in the past few years. Overall feed sales grew at an average annual rate of 7% between 1978-1982 but declined sharply in 1983 and 1984 because of the problems discussed earlier. Rapid inflation and other economic uncertainties continued to hurt all sectors during the last two years, including hogs and poultry. Table 4.5 shows feedstuff imports into the Philippines in 1983. Imports of some 834,000 MT represent 85 percent of total feed sales in 1983 (975,000 MT -- Table 4.4). Local sources of feed raw materials, excluding corn, amounted to 89,000 MT in the same year (Table 4.6).

Table 4.4  
Estimated Total Sales of Commercial Feeds in the Philippines  
(000's of 50 kg bags)

<u>Feed</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>
Poultry	15,066.4	15,542.1	15,975.5	17,177.4	19,357.1	--	--
Hogs	3,853.3	4,198.6	4,621.8	5,220.0	5,501.0	--	--
Total	18,919.7	19,740.7	20,597.3	22,397.4	24,858.1	<u>19,500</u>	17,195
						(or 975,000 MT)	

Source: Philippine Association of Feed Millers, Inc. (PAFMI)

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Table 4.5  
Volume and Value of Feedstuff Imports in 1983

<u>Feedstuff</u>	<u>Volume (MT)</u>	<u>Value (000 US \$)</u>
Corn	520,643	77,200
Soybean Meal	260,594	65,000
Meat & Bone Meal	38,514	9,852
Fish meal	13,653	4,857
Meat meal	<u>117</u>	<u>24</u>
Total	833,881	157,033

Source: Feed Control Division, Bureau of Animal Industries

Table 4.6  
Volume of Feed Raw Materials from Local Sources, 1983

<u>Feedstuff</u>	<u>Volume (MT)</u>
Fish Meal	3,202
Bone Meal	1,285
Copra Meal	56,339
Corn Bran	16,197
Ipil-Ipil leaf meal	8,748
Feather Meal	1,015
Yeast	588
Feed Supplements	<u>1,698</u>
Total	89,072

Source: Feed Control Division, Bureau of Animal Industries

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To a large extent, the high cost of meat and poultry is a direct result of high feed prices, which constitute up to 70% of the total cost of production in the larger commercial operations. Concentrated feeds, in turn, are expensive in the Philippines because of their high import content and because of currency devaluation in recent years. Between 1983 and 1984 alone, the average production cost of poultry feeds increased 121% to P 198.69 (\$9.69) per 50-kg bag, and hog feed prices increased 109% to P 160.90 (\$7.85) per 50 kg-bag. Because of their high protein content (35-42%), shrimp feeds are even more sensitive to high cost inputs. A domestic shrimp feed produced by San Miguel costs P 31 (\$1.51)/kg compared to P 24 (\$1.17)/kg for President's feed imported from Taiwan. Non-currency related disparities in feed ingredient costs between the Philippines and other countries might be attributable to differences in import duties, tight local supply conditions, or other reasons. A comparison with Thailand is shown in Table 4.7.

Table 4.7  
Comparison of Wholesale Feedstuff Prices  
for Thailand and the Philippines  
(as of January 1985)

Ingredient	Wholesale Price in Thailand	Wholesale Price in Metro Manila	
	(Peso Equivalents/kg)	(pesos/kg)	(¢/lb)
Corn	1.95	3.90	(8.6)
Soybean meal			
local	4.83	--	--
imported	4.55	6.70-8.0*	14.9-17.7*
Fish meal			
local	6.65	13.00	28.8
imported	--	15.50	34.4
Rice bran	2.30	2.35	5.2

\* Soybean meal price range for quotes from June-August, 1986.

Source: Villegas, 1985

The impact of rising feed prices on producers has been dramatic. Thirty to forty percent of the small poultry and hog raisers ceased operations in 1984. These closings led to increased wholesale and retail prices for chicken and pork and further eroded the ability of producers to compete in export markets. As a consequence, a 1985 report from the Land Bank of the Philippines on the livestock, poultry and feed milling industry called for actions to ameliorate the industry's current problems:

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- Programs to increase yellow corn, soybean and feed root crop production;
- Improved physical infrastructure and financing programs for the transport of feed and animal products;
- Program for increasing fishmeal production and reducing imported feedstuffs by the fishing industry;
- P 50 million (\$2.5 million) for R&D into the production of non-conventional feed raw materials from local sources;
- Import substitution strategy to discourage dependence on imported feed materials;
- Program to help reduce the cost of importing breeding stocks (Villegas, et al., 1985).

Future growth of the livestock, poultry and fishery industries is not strictly dependent on the development of large local sources of quality feedstuffs, as the innovative experience of a number of Philippine operators has demonstrated (e.g., Monterey Farms' use of pineapple and banana wastes to supplement rations). However, the large-scale expansion of these industries will require the development of domestic sources of feed ingredients in order to gain a degree of protection from the uncertainties of import supplies and currency fluctuations, and to establish operations which are more vertically integrated and which offer the potential for greater cost reduction. In addition, the industry seems to recognize at this time the importance of investigating non-traditional sources of carbohydrates and protein. This recognition helps establish support for an examination of feed production opportunities associated with sugarcane and the sugar industry.

### 4.2 Feed Production Technologies

As the production of meat and marine products expands in the Philippines, both for domestic consumption and export, lower cost feeds and reliable year-round supplies will become necessary for the industry to grow. Commercial developments in the production of animal feeds from sugarcane offer the potential to greatly ameliorate problems now faced by the poultry, livestock and fishery industries. This section reviews the technical options for producing feed ingredients, both protein and carbohydrate (or fodder), from the constituents of sugarcane and from other products of sugarcane processing such as alcohol.

#### 4.2.1 Feed Protein

Protein is an essential ingredient in all animal diets and ranges from 10-11% in prepared feeds for dairy cattle, and 19-22% for poultry feeds, to as high as 35-40% in shrimp feeds. The use of prepared feeds requires the import of over 300,000 MT of soybean meal and other protein ingredients annually to the Philippines, which cost

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over \$80 million in foreign exchange in 1983 (Table 4.5). Attempts to grow soybean in the Philippines have so far proven unsuccessful, and production of other protein sources (ipil-ipil leaf meal, fish meal, bone meal) is quite limited, amounting to only 13,500 MT/yr (Table 4.6). (1)

Yeast production represents a vast potential protein source for the Philippines. Yeast is a proven substitute for soybean meal (42-48% protein) in many feed formulations, is usually richer in vitamins and minerals, and will often out-perform soybean meal in comparative tests. (2) Its nucleic acid content poses some limitations on the quantity that can be used in poultry formulations (Carangal, 1986).

Currently, use of yeast for feed is small (just over 500 MT/year), but a number of commercial systems could easily be applied in the sugar industry. Yeast can be grown on a variety of substrates, as shown below. The most widely available source of yeast protein today is brewer's yeast (Saccharomyces cerevisiae) produced as a by-product of alcohol fermentation.

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<u>Substrates</u>	<u>Processes</u>	<u>Products</u>
Distillery feedstocks (Molasses, Cane Juice, Other)	Yeast-Growth Phase prior to Alcohol Fermentation* Waldhof Fermentation*	Brewer's Yeast Torula Yeast
Stillage	Biowastech Process*	Candida Ingens Yeast
Treated Lignocellulose	Experimental Aerobic Fermentation	Yeasts, bacteria and fungal Single Cell Proteins

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\*These are all examples of aerobic fermentations

The growth of yeast requires sugar or another metabolizable organic substrate and aerobic conditions (presence of oxygen). In an alcohol distillery, yeast is grown on molasses or cane juice feedstocks to a sufficient cell density, then air is cut off and the fermentation switches to produce ethanol instead of more yeast cells. Yeast is recovered, either for re-use in the distillery or for feed purposes, by means of centrifuges or settling tanks. With the prospect of increased alcohol investments in the sugar industry, opportunities for yeast recovery as protein feed supplements may be promising.

Commercial yeast production does not require alcohol processing, however. For example, by maintaining aerobic conditions in yeast propagation, high yeast yields (50%) can be achieved from molasses and cane juice (with the appropriate nutrients).

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Different yeast strains, Torula or Fodder yeast (Candida utilis or Torulopsis utilis) are preferred for their ease of maintenance, fast growth, good pentose-utilizing abilities, good nutritional properties, and tolerance of a wide range of substrates (Hajny, 1981). (3) The commercial production of such yeast is usually confined to low-grade sugar sources such as sulfite pulping wastewaters and blackstrap molasses. However, the rather high value of yeast and low value of surplus sugar in the Philippines might make yeast production from cane juice an attractive option for the sugar industry in the near term. Furthermore, energy requirements for torula yeast production would be lower than for sugar production, and this can make quantities of bagasse available for fodder and energy applications. However, the energy requirements for producing a dried yeast product are considerable and can exceed the energy needed for alcohol production.

Yeast is easily separated by centrifuging the fermentation broth or allowing the broth to settle in a separating tank if the yeast has the propensity to flocculate. The use of centrifuges for separation adds significantly to the capital cost and energy requirements of a yeast recovery plant. (4) Equipment to dry the yeast also adds to capital costs and energy requirements. A substantial savings could be realized if yeast cream (10-20% solids) was sold directly to avoid the drying step. However, the wet product would have to be consumed within 24 hours to avoid spoilage. Dried yeast at 3-8% moisture can be stored at room temperature for several years without problems.

Although not yet commercially practiced, yeast can also be grown on organic wastewaters such as stillage (also called vinasse and slops). For every litre of alcohol, 10-16 litres of stillage containing 0.72-0.84 kg of organic wastes is produced. This waste is heavily contaminated with organic compounds and nutrients, and represents a major disposal problem for distilleries. (5) The yeast, Candida Ingens, grows on such wastewaters and the process is purported to have been demonstrated at a rum distillery in Australia. (6) The ability to produce yeast protein from a waste stream that would otherwise be a costly disposal burden represents a fundamental improvement in alcohol production technology and provides a possibility for integrating sugarcane/alcohol processing and feed production.

A number of unproven processes seek to produce yeast, algae and single-cell proteins by novel means and some are nearing commercial application. Treated lignocellulosic materials, such as hydrolyzed bagasse (see next section), release significant quantities of fermentable sugars which can be aerobically fermented in the solid state to produce yeast. Furthermore, the solid state fermentation of treated residues with cellulolytic (cellulose degrading) organisms such as the fungus, Chaetomium cellulolyticum, can afford high conversions of lignocellulosic substrates to single cell protein (Moo-Young, 1985). The growth of protein-rich bacteria and fungi has also been investigated.

Alcohol plants could also use stillage as a nutrient medium for the culture of protein-rich algae. Algae cultures could also use the carbon dioxide produced as a distillery by-product. The algae, Spirulina, for example, is 68-70% protein and is

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proven to be an excellent substitute for soybean meal in aquaculture, poultry and swine rations. Commercial development of such algae production processes is currently underway in a number of locations. (7)

Proteins can be produced directly from sugar products or from various byproducts and wastes. Although not without problems, fermentation to produce yeast from sugars is well understood and widely accepted, having undergone commercial refinement since the 1930's. Costs are highly variable and depend on a number of factors. (8) Some relevant research has been carried out in the Philippines.

### 4.2.2 Feed Carbohydrates (Fodder)

Sugars and carbohydrates provide most of the energy content of animal feeds. Sugarcane juice is, of course, readily digestible but there is no component of cane comparable to starch, the prevalent carbohydrate in corn and other grains and tubers. Cane juice has not been used historically as a feed sugar, although molasses has long been used in this way. Ruminants (cattle, goats, sheep) are only able to utilize the sugars in lignocellulosic materials to a limited extent. Most grasses are readily digestible although tougher materials such as bagasse and wood have limited digestibility unless first subjected to some form of disruptive treatment.

This class of partially digestible carbohydrate feedstuffs is termed fodder and a substantial amount of effort has been devoted to the development of methods for producing fodder from sugarcane, bagasse and field trash (tops and leaves). Simple treatment techniques are now in use that break down the resistant structure of bagasse lignocellulose. For example, feeds based on bagasse and other fibrous residues support commercial feedlot operations in Brazil and elsewhere.

Some cane-derived fodders can be used directly without pretreatment. Bagacillo, fine bagasse derived from cane pith which can be separated from raw bagasse fiber during milling, is more digestible to ruminants than raw bagasse. Several sugar companies outside the Philippines offer feeds formulated with bagacillo. Cane tops and field trash are also collected in a number of places for direct feeding of livestock. Chopped cane has occasionally been used as fodder (First Farmers, Gamboa Hermanos and Monterrey Farms have done tests in the Philippines), but it is not very palatable to the animals and results show poor weight gain. (9)

Table 4.8 summarizes the treatments available for enhancing the digestibility of bagasse and other lignocellulosic residues. It is important to point out that these alternatives are based on residues from existing sugar mill and field operations. Bagasse is generated in surplus at many sugar mills and serves as the raw material for Brazilian feedlot operations. Cane tops and field trash can augment residue supplies, especially where fields are not burned prior to harvest.

Steam autohydrolysis refers to subjecting lignocellulosic materials to steam at elevated temperatures (100--170° C) and pressures to disrupt the protective lignin-hemicellulose matrix. Autohydrolysis renders bagasse as digestible as high

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quality green pasture and considerably more palatable than raw bagasse, resulting in larger weight gains per unit of feed. The bagasse is also stable and can be stored for up to 6 months because the treatment sterilizes the material and the low pH prevents contamination. In practice, this treatment increases the in-vitro digestibility of bagasse from 35% to 65%. (Autohydrolyzed bagasse properties are compared with those of raw bagasse in Table 4.14 in the Technical Notes) (10).

Autohydrolysis is probably the most widely-accepted treatment method and can take advantage of surplus exhaust steam generally available at the sugar mill. The process has been under development for the past 5 years in Brazil, now supporting 3000 head of cattle in a confined feedlot associated with an alcohol distillery. The total cost for producing the balanced feed is \$15.40/ton at 50% moisture (January 1985 cost). (11)

Table 4.8  
Technology Options for Residue Digestibility

<u>Treatment</u>	<u>Inputs</u>	<u>Status</u>	<u>Reference</u>
Autohydrolysis	Steam	Commercial	Navarro, 1985
Hydrolysis	Alkali - Na <sub>2</sub> O	Commercial	Unger, 1985
	- urea (urine)	Experimental	Wanapat, 1985
Oxidation	Hydrogen Peroxide	Experimental	Kerley, 1985
	Ozone	Experimental	Owen, 1984; Ben-Ghedalia, 1982

Alkaline hydrolysis is a second treatment in limited commercial application, also in Brazil, and has the advantage of being suitable for year-round operations. This simple technique consists of mixing ground bagasse with an aqueous solution of caustic soda (Na<sub>2</sub>O) for a brief period at ambient conditions. Under these conditions, the alkaline solution will hydrolyze the hemicellulose quite readily although the degree of hydrolysis may be somewhat lower than that achieved by steam treatment under more severe conditions. Salt, urea and a protein complement such as yeast are then mixed with the treated bagasse prior to feeding. The cost of a balanced ration including additives is comparable to hydrolyzed bagasse, ranging from \$13.86 to \$15.40/ton, depending upon the size of the animal and the corresponding formulation required. (12) Results in animal performance are also comparable. (13)

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Alkali treatment of rice straw has been studied in the Philippines but did not appear attractive because rice straw already has a relatively high level of digestible nutrients and is too dispersed. Some studies with urea treatment (which is a weakly alkaline compound) of straws showed improved digestibility and additional nitrogen in the resulting fodder (Arboleda, 1986). Reports of urea treatment of the tougher material, bagasse, have found it too weak to have much effect on digestibility (Wanapat, 1985).

Other techniques are being tried and may yield useful results in the future. (14) Applied research indicates that adding the oxidant hydrogen peroxide improves the effects of alkaline treatment (Kerley, 1985). Recent studies also indicate that oxidation with ozone might be more effective than hydrolysis with certain feedstocks, such as cotton stalks, but ozone is expensive costing approximately \$20/ton of treated material (Ben-Ghedalia, 1983).

### 4.2.3 Integrated Operations

Feed production from cane residues can benefit from linking sugarcane processing operations with animal feeding. Integration eliminates transportation costs and permits the use of more "as-is" products without drying and/or storage. Both sugar-rich wastewaters generated by yeast processing and manure produced by livestock can be used as fertilizer in adjacent cane fields. Alcohol production could also be integrated given appropriate market conditions. Figure 4.1 depicts a system in which animal and alcohol production are integrated; a number of variations on this concept are practical.

In the Philippines, the sugar mill would replace the distillery (there are no autonomous distilleries using cane juice in the Philippines), a yeast plant could be added to provide more feed ingredients, and hogs or poultry could replace the cattle. The opportunity to substitute yeast for soybean meal already has been identified by one Philippine sugar company which also operates a separate poultry feed mill and is seeking cheaper sources of protein. Integration would be an easy step. (15)

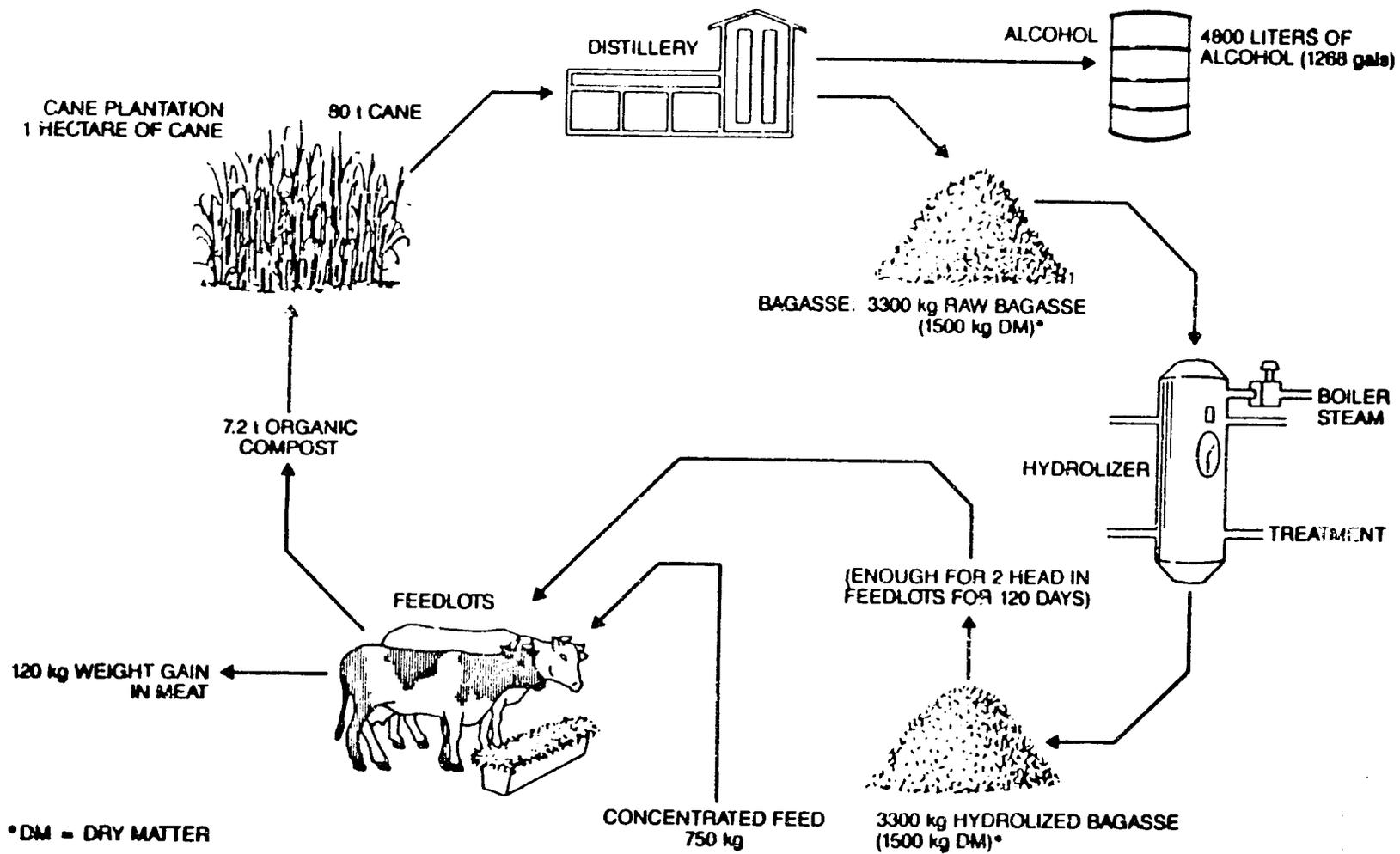
## 4.3 Prospects for Feeds in The Philippines

This section examines the prospects for applying the feed techniques discussed above in the Philippines sugar industry and market environment.

### 4.3.1 Yeast Protein Potential

The potential yeast market is some 260,000 MT, or the current level of soybean meal imports (section 4.1). Yeast is already recovered from stillage in the Philippines for substitution of soybean meal, but at a low level. Its price, P3.5-5.0 or 8-11¢/lb, is lower than that for soybean meal (P6.7-8.0/kg or 14.9-17.7¢/lb), because it is sold as less desirable yeast cream. This would change with drying and bagging.

**Figure 4.1**  
**Integration of Livestock Production**  
**with an Alcohol Distillery**



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Potential feedstocks for protein production in the Philippine sugar industry are molasses, cane juice and stillage. Projected cane production of 15.5 million MT 85/86 will yield approximately 555,000 MT of molasses which could be converted into 150,000 MT of yeast (42% protein). However, the current export market for surplus molasses is strong, at a price of P 1200/MT (\$59/MT), and reduces interest in making capital investments in facilities to convert molasses to yeast. Nevertheless, if converted to yeast, a MT of molasses would displace \$100-\$110 worth of soybean meal at current prices, almost twice the dollar value of molasses exports.

Although the production of yeast protein from cane juice is not common, it is well understood and appropriate to consider under present price circumstances. Feed markets could sustain a substantial amount of sugarcane production. Replacement of the 260,000 MT of soybean with yeast protein would require cane juice from 4 million MT of sugarcane. A yeast plant annexed to a sugar mill using cane juice as a feedstock could boost the capacity utilization of a mill in much the same way an annexed ethanol distillery can, without increasing sugar output.

Yeast production from cane juice or molasses is a well-established option in terms of technology and product market acceptance. Numerous vendors offer yeast production technology and many in the sugar industry have considered this option. The reason it has not been introduced in the Philippines appears to be that vendors know little about how to adapt their systems to circumstances in the Philippines. For example, firms are reported to have offered estimates for sophisticated systems (human food quality yeast; systems using exotic feedstocks such as methanol) with high production costs. Estimates indicate that a simplified yeast plant using cane juice or molasses costs far less but these plants have not been offered.

Table 4.9 presents a comparison of two yeast plant quotes (estimates only), one autonomous plant producing human food yeast (high cost) and one annexed facility at a sugar factory (low cost). If yeast is priced near the price of soybean meal (\$330-390/MT, depending upon a range in yeast protein content of 42-48%), then its production from cane juice may well prove economically feasible. (16)

The potential merit of yeast production can be compared to ethanol as a diversification option for the sugar industry. The metric ton of cane required to produce 100 kg of sugar will yield 66 litres of alcohol or 65 kg of yeast. If the alcohol is priced at 28¢/l (current US price) the value of alcohol from 1 MT of cane will be \$18.48. If yeast is priced equal to soybean meal, the value of the yeast will be \$24.31, (value of yeast having 48% protein) about 30% higher. Also, the immediate ability to substitute yeast for soybean meal in the feeds industry is perhaps considerably more feasible than marketing ethanol as a blending agent with gasoline.

Stillage wastewaters from alcohol distilleries represent a third potential sugar industry feedstock especially if the Philippines expands alcohol production. As noted, stillage has traditionally been a disposal problem, but recent advances in yeast and algae culture suggest ways to effectively use it as a feedstock for protein products while also improving the economics of distillery operations. Recently, the

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technology has been demonstrated at a commercial scale although more work is needed to demonstrate commercial viability. The fundamental reasons for considering it are compelling.

The quantities of stillage available in the Philippines are summarized in Table 4.10. Excluding the two distilleries which have made major investments in treatment systems, Tarlac and Victorias, 3.4 million l/day of stillage containing 2.7 million kg/day of organic waste is available for conversion to yeast. This represents a potential production of 560-800 MT/day of yeast, or 101,000-144,000 MT/yr, assuming that the distilleries operate 180 days/year. Given the current status of the technology, capital investments for the process (Biowastech) will be high, but it is estimated that a net credit of approximately 5¢ per liter of alcohol produced may be realized.

Table 4.9  
Comparison of Yeast Production Costs  
(10,000 MT/yr yeast plant using cane juice)(17)

	Autonomous Plant -US Site-	Annexed Plant Developing Country Site
Capital Investment (\$)	35,200,000 <sup>1</sup>	4,000,000 <sup>2</sup>
<u>Production Costs (\$/Ton)</u>		
Feedstock	240 <sup>3</sup>	177 <sup>4</sup> (213) <sup>5</sup>
Nutrients and Minerals	140	8
Utilities		
Electricity 2000kwh	100	50 <sup>6</sup>
Steam 27.1x10 <sup>3</sup> lb	190	0 <sup>7</sup>
Gas 18.9x10 <sup>6</sup> Btu	85	0 <sup>8</sup>
Cooling water	9	9
Labor (57 employees)	57	12
Investment costs	<u>235</u>	<u>13</u>
Total Cost (\$/Ton)	1,056	282

1 Source: Christensen, 1986

2 Sources: Upton, 1986; Nabisco (1986); Abay (1986)

3 Based on a world market sugar price of 6¢/lb.

4 Based on average production cost of P 230/TC, 135 kg reducing sugars/TC and a 45% yield of yeast. Assumes costs for grinding cane are sunk costs.

5 Molasses feedstock cost at \$58/MT

6 Cost at the transfer price of mill-generated electricity

7 Steam provided by burning bagasse and from surplus steam

8 Gas-fired dryer not used/steam-heated dryer used instead

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Table 4.10  
Stillage Production in Philippine Distilleries

Distillery	Alcohol Capacity (l/d)	Stillage Generated (l/d)*	Current Treatment System
Hind	4,500	40,500	Not Surveyed
Paniqui	10,000	90,000	Not Surveyed
Tarlac	45,000	455,000	Anaerobic Digestion/Lagoon
Don Pedro	27,000	243,000	Lagoon
Santos-Lopez	8,000	72,000	Not Surveyed
Talisay-Silay	26,000	234,000	Not Surveyed
Victorias	47,700	472,000	Aerobic Treatment Lagoon
La Carlotta	22,500	225,000	Lagoon
Biscom	30,000	270,000	Not Surveyed
Asian Alcohol	210,000	2,100,000	Lagoon/Ocean Discharge
Kool Alcohol	20,000	180,000	Ocean Discharge
Total	450,200	4,376,500	

\*Calculated on a basis of 10 l stillage/l alcohol for anhydrous alcohol and 9 l stillage/l alcohol for potable alcohol.

The proper treatment of stillage in aeration lagoons costs 3-5¢/l of alcohol (Deypalan, 1986). The other alternative in use, anaerobic digestion, does produce fuel as a by-product but the fuel savings involved rarely justify the costs of the digestion system. One anaerobic digestion system being used with stillage which claims fuel savings sufficient to generate a positive return on the system investment is at the Destileria de Tarlac in the Philippines. Another alternative way to use stillage is to mix it with irrigation water but its value in this application is miniscule.

### 4.3.2 Fodder Potential

Bagasse, bagacillo, and field trash and tops could be used to produce fodder or carbohydrate feeds. The attractiveness of producing fodder from these feedstocks is complicated by uncertainties in fodder markets and feedstock supplies.

The market for cane-derived fodders is very difficult to estimate. Most cattle produced in the Philippines are raised on forage. Little supplementary feeding is done, not necessarily by choice but as a consequence of the extremely high feed prices in the Philippines. If a low cost balanced feed was available, a market for the product would certainly develop and commercial feedlot production would probably

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increase from its current level of 25%. Replacement of high quality imported beef (currently \$20 million per year) with domestic beef would require about 45,000 MT/yr of hydrolyzed fiber plus protein and other supplements. To feed all the beef now produced commercially in the Philippines would require 1 million MT/yr of hydrolyzed fiber.

One of the impediments in achieving a significant market for sugarcane-derived feeds is that the feed purchaser must perceive an added value in using prepared feeds; i.e., better quality meat that commands a premium value. A meat grading system is crucial to stimulate this development. The current lack of market for fodder combined with the limited commercial development of bagasse treatments, will serve to make any introduction of fodder from sugarcane technology gradual.

Uncertainty about the availability of feedstocks from which to produce fodder because of recent fluctuations in sugar markets also decreases its attractiveness. Even assuming predictable sugar output, the availability of bagasse as a feedstock for fodder production depends on competing uses. Bagasse is currently burned in most mills to provide steam and power to sugar mill operations. The size of existing bagasse surpluses can be used as a crude measure of bagasse availability but is by no means accurate because mills have traditionally viewed bagasse beyond that needed for power and steam as a disposal problem. New markets could quickly increase its availability.

No comprehensive survey of bagasse surpluses at existing sugar mills has been performed. The sugar industry in 1979 met 86% of its energy needs by burning bagasse (MOE, 1979) indicating that a great deal of bagasse is already consumed. A spot survey of 18 mills conducted in the course of this study identified 13 mills that had a combined bagasse surplus of 185,293 MT. This bagasse is either sold, given away as fuel to surrounding businesses, or is land-filled. Table 4.11 lists Philippine sugar mills, their rated capacities and bagasse surpluses. In general, those mills that have either a distillery (\*) or a refinery (\*\*) or both (\*\*\*) are not likely to have surplus bagasse because of the added energy needs of these operations. Mills with bagasse surpluses on Luzon are prime candidates as sites for producing bagasse-based fodders because of their proximity to the principal areas of commercial cattle production.

Estimating the availability of cane tops and field trash as a feedstock for fodder production is also difficult because there is limited history of organized collection and use. (See Section 3.1 for discussion of the quantity of cane tops and field trash available.) Some cane tops are collected by hand for local use as fodder in Negros. An AID-sponsored evaluation in Jamaica indicates that trash can be collected mechanically and delivered to a mill for \$10.50/dry ton.

The Tarlac mill in the Philippines has mechanically collected and baled trash in tests for co-firing with bagasse. Tarlac management believes that trash collection is feasible and that up to 12 MT of trash per ha (25% moisture) can be recovered. Other mills with sophisticated harvesting and transportation systems such as the Don Pedro mill in Luzon are in an excellent position to use their systems to collect field trash with little added capital investment. Most companies, however, have inefficient systems for harvesting and transporting cane, and the potential for collecting trash cannot be predicted.

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Table 4.11: PHILIPPINES SUGAR MILL CHARACTERISTICS

Rank	Mills	Location	Rated Capac. (tc/day)	Annual Bagasse Surplus (MT/yr)
1	Bobo-Medellin	Cebu	2,500	not surveyed
2	Canlubang*	Luzon	6,100	9,584, 4.2%
3	SONEDCO /c	Negros	4,000	not surveyed
4	Don Pedro*	Luzon	6,300	all consumed
5	First-Farmers	Negros	4,500	25,000, 13%
6	AIDSISA /c	Negros	4,000	not surveyed
7	BUSCO** /b,/c	Mindanao	4,000	12,861, 12%
8	San Carlos	Negros	4,000	4,000, 4.1% /d
9	Hawaiian-Phil	Negros	6,200	5,900, 2.3%
10	Dacongogon /c	Negros	1,500	not surveyed
11	Tarlac***	Luzon	7,000	12,000, 5.2% /a
12	La Carlota***	Negros	10,000	all consumed
13	BISCOM*	Negros	10,000	not surveyed
14	Sagay /c	Negros	3,000	not surveyed
15	VICMICO***	Negros	10,000	15,000
16	Batangas**	Luzon	4,000	not surveyed
17	Paniqui*	Luzon	1,500	3,250, 6.7%
18	UPSUMCO /c	Negros	4,000	all consumed
19	Durano	Cebu	2,000	13,235, 15%
20	Lopez	Negros	7,500	not surveyed
21	PASUDECO	Luzon	6,500	33,400, 25%
22	Passu /c	Panay	4,000	26,341, 20%
23	Santos-Lopez*	Panay	2,600	not surveyed
24	Austurias	Panay	2,000	not surveyed
25	Bacolod-Murcia	Negros	3,600	6,082, 6%
26	Ormoc /c	Leyte	2,500	not surveyed
27	BUSYDECI /c	Kyzib	4,000	not surveyed
28	Tolong /c	Negros	3,000	not surveyed
29	Pilar	Panay	3,500	not surveyed
30	Hind*	Luzon	523	all consumed
31	CASUCO** /c	Luzon	4,000	not surveyed
32	Calinog-Lambunao** /c	Panay	4,000	not surveyed
33	Allied	Panay	3,000	not surveyed
34	Bais*	Negros	8,000	not surveyed
35	Talisay-Silay*	Negros	3,600	not surveyed
36	HIDECO	LEYTE	5,000	29,208, 22%
37	Ma-Ao	Negros	6,000	not surveyed
38	NOCOSHI /c	Mindanao	4,000	1,432, 11%
39	Danao	Negros	3,000	not surveyed
40	NASUDECO*	Luzon	5,600	not surveyed
41	Davao **	Mindanao	4,000	not surveyed

/a Bagasse surplus used for running distillery during off-season.

/b 6,000 tonnes of cane per day (TCD) in crop-year 1983/84.

/c Mills heavily indebted to gov't. banks and taken over by Philsucor.

/d Bagasse sold to pulp mill for feedstock.

\* With distillery.

\*\* With refinery.

\*\*\* With both distillery and refinery.

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Given the attractiveness of producing protein from sugar at current prices, the potential to produce fodder from bagasse and field residues, and the collapse of the Philippine sugar market, an existing mill could, ostensibly, be dedicated exclusively to the production of feeds. However, it is much more logical to use existing grinding capacity and utilities by annexing yeast and fodder plants to sugar mills now under-utilized, at least until the operation and economics of feed production technologies are firmly established in the Philippines.

Another possible alternative for growing cane for feed markets is simplified small scale processing where the cane would be chopped and allowed to ferment as an unseparated mash to boost the mash's protein content, followed by treatment with heat or alkali to make the fiber more digestible. Such a process would be most useful to small farmers who cannot afford or gain access to prepared feeds. Techniques are reported to be in use in Trinidad and Guatemala.

### 4.4 Conclusion

In summary, the evaluation of possible feeds applications within the sugar industry has identified yeast protein production as a promising diversification option. The technology is proven and the market as a soybean meal substitute is clearly defined. A feasibility study at a specific site would provide a decisive determination of the commercial viability of yeast production. The design basis should be flexible enough to accommodate cane juice, molasses and stillage as feedstocks. This will allow the running of commercial-scale tests once the facility has been established using proven technologies.

The potentials for producing fodder from bagasse and whole cane are less easily defined but clearly merit further investigation because of the availability of feedstocks. This option is technically feasible but major questions exist concerning the potential market for the product. A market analysis should precede technology demonstration efforts concentrating on commercial feedlots which are more dependent on prepared feeds than small farmers. The study should also focus on sugar companies currently involved in livestock production through parent or subsidiary companies. Both steam and alkaline hydrolysis appear attractive in producing a balanced feed product at reasonable cost. The choice of which technique to use will depend on site-specific circumstances.

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### Notes

1. The growing use of Ipil-Ipil leaf meal (8,748 MT in 1983) is the principal innovation in feed protein production in the Philippines. Dried Ipil-Ipil (*leucaena*) leaf meal contains 25-30% protein and is now widely used as a cattle feed. However, the leaf contains an unusual amino acid, Mimosine, which in some animals has adverse effects (hair loss, abortion, delayed sexual maturity, slow growth). Ruminants are able to break Mimosine down but poultry are susceptible and exhibit adverse effects if the amount of leaf meal in their diet exceeds 6% (NAS, 1984). Since 78% of all feeds currently produced are for poultry, Ipil-Ipil leaf meal substitute potential is limited.

2. In addition to often having a higher protein content, yeast is richer in B vitamins, minerals, calcium and phosphorus. One drawback worth noting is that most yeasts are deficient in the sulfur-containing amino acids, cysteine and methionine. This is of no consequence in animal feeds, but these amino acids should be supplemented in some rodent and avian feeds. The comparison of various types of yeast to soybean meal is shown below in Table 4.12. The comparative performance of soybean meal and yeast-based feeds in pigs is shown in Table 4.13.

Table 4.12  
The Composition of Soybean Meal and Selected Yeasts  
(percent by weight)

Component	Soybean Meal (expeller)	Brewer's Yeast(1)	Torula Yeast(2)	Biowastech Yeast(3)	Provesteen Yeast(4)
Protein	42.0	54.7	46.7-54.2	38-58	43.8-62
Fat	3.5	5.6	3.76-5.82	--	4.3-5
Carbohydrates (by difference)	--	29.4	--	--	18-24
Moisture	--	3.3	--	--	4-5.5
Ash	6.0	7.0	5.56-9.53	--	11-18.8
Calcium	0.25	0.12	0.13-0.90	6	0.01-2.2
Phosphorus	0.6	1.5	1.19-2.08	7	2.5-4.1
Sodium	--	0.04	--	--	0.01-2.2

(1) *Saccharomyces cerevisiae* - source El Consult, 1985

(2) *Candida utilis* - source, Hajny, 1981

(3) *Candida ingens* - source, Henry, 1983

(4) proprietary strains - source, Norell, 1984

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Table 4.13  
Comparative Performance of Soybean Meal and  
Yeast In Weanling Pigs

	18% Protein Diet Using:	
	<u>Soybean Meal</u>	<u>Provesteen P Yeast</u>
Feed per kg of gain, kg	3.25	2.74
Apparent dry matter digestibility, %	91.5	94.4
Apparent N digestibility, %	89.3	94.0
True N digestibility, %	92.6	96.8

Source: Slagle, 1979

3. Provesta Corporation, a subsidiary of Phillips Petroleum, has developed a series of proprietary yeast strains (Provesteen T,K,P) that reportedly are well-adapted to sugar substrates and yield 0.45 kg of yeast per kg of sucrose or molasses (Christensen, 1985). Other firms (Linde, Vogelbusch, ICI Amoco Foods and Hoechst) have been actively promoting yeast single cell protein (SCP) technology based on methanol and ethanol feedstocks (CW, 1979). The use of alcohols as feedstocks makes little sense for the Philippines where sugars are so readily available and inexpensive.

4. The total investment (installed) for yeast recovery, spray drying and bagging equipment is estimated at US\$620,000 for a 120,000 l/d distillery excluding the centrifuge, and \$1 million including centrifuge (Fuel Alcohol Production in Honduras, USAID, April 1986). Drum dryers are actually used more widely than spray dryers and drying is quite energy-intensive.

5. Solids concentrations for stillage from alcohol plants range from 1.2% when corn is the feedstock to 6.7%-8.7% when blackstrap molasses is the feedstock. The composition of stillage from an alcohol plant using cane juice is as follows (% by weight):

Water	98.58	Ash	0.22
Solids	1.42	Lignin, phenol	0.19
Sugars	0.717	Glycerine	0.08
Gums	0.33	Lactic Acid	0.08
Protein	0.22	Fiber	0.01

(Source: El Consult, 1985)

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6. Queensland Science and Technology, Ltd. recently announced the successful commercial-scale test at a rum distillery of its Biowastech process based upon a novel, versatile yeast, Candida ingens. The yeast was originally developed to produce protein from piggery wastes but has subsequently been adapted to utilize distillery stillage as well as more conventional sugar substrates (QS&T, 1984).

7. It is possible to produce protein by the culture of algae such as Spirulina which contains 68-70% protein (Hunter, 1985). Spirulina is now grown commercially as a high value specialty food (\$10/kg) but production costs have not yet been reduced sufficiently to render Spirulina culture an economical source of feed protein. Spirulina is cultured in several lakes in Chad and Mexico and in shallow oval raceway ponds.

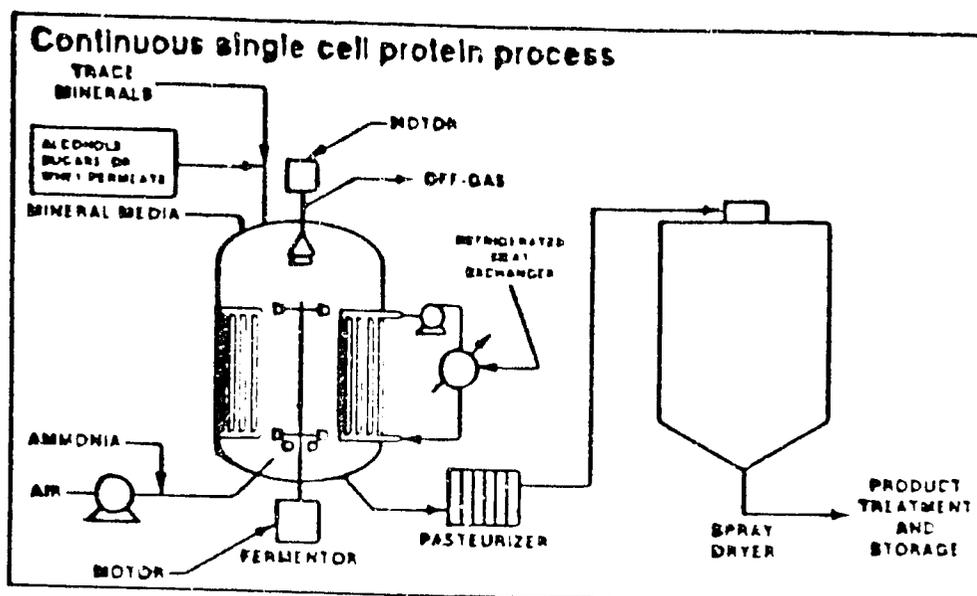
A promising avenue for lowering the cost of Spirulina production is by using waste organic materials such as distillery stillage. The use of a photosynthetic process can also make use of carbon dioxide produced in the distillery (Behrends, 1985). It is theoretically possible to produce 1 1/2 kg of algae from the stillage left after producing one liter of alcohol. If algae protein value is equal to that of soybean meal, then its value approaches the value of the fuel alcohol.

The capital investment for a 4,500 MT/yr facility annexed to a distillery is estimated at \$3.5 million, versus \$10 million for an autonomous facility. Operating cost estimates (from a largely theoretical analysis) indicate that Spirulina could potentially be produced for 34¢/kg in an annexed facility, \$1.32/kg in an autonomous facility (Zaborsky, 1985, Klausmeier, 1986). The recovery of high value specialty chemicals such as xanthophyll and linolenic acid offers a means of improving feed economics. Additional research will be required before algae culture is proven commercially viable for feed production.

8. The production of fodder yeast by aerobic fermentation is not without complications. These yeasts have a tendency to foam up during fermentation which necessitates the addition of antifoam agents or the use of mechanical foam breaking. To prevent foaming, the fermentation process must be vigorously aerated, otherwise unwanted by-products will form. The power requirements for aeration can represent 50% or more of the yeast production costs. A number of different fermenter configurations with mechanical stirring and air supply have been examined. The basic components of these designs are shown in Figures 4.2 and 4.3.

The continuous stirred reactor design used by Provesta employs mechanical foam breakers to control foam and actually takes advantage of foaming to achieve high oxygen transfer rates. An extremely high cell density can be achieved (120-150g yeast dry wt./liter) presumably because the strains developed resist the inhibitory effects of high osmotic pressures. High cell densities preclude the need for centrifugation. Another stirred reactor, the Waldhof propagator utilizes a central draft tube to circulate foam and maintain the fermentation as an emulsion which also greatly enhances oxygen transfer rates. However, the maximum cell density for this fermenter is only about 25g yeast dry wt./liter (Hajny, 1981).

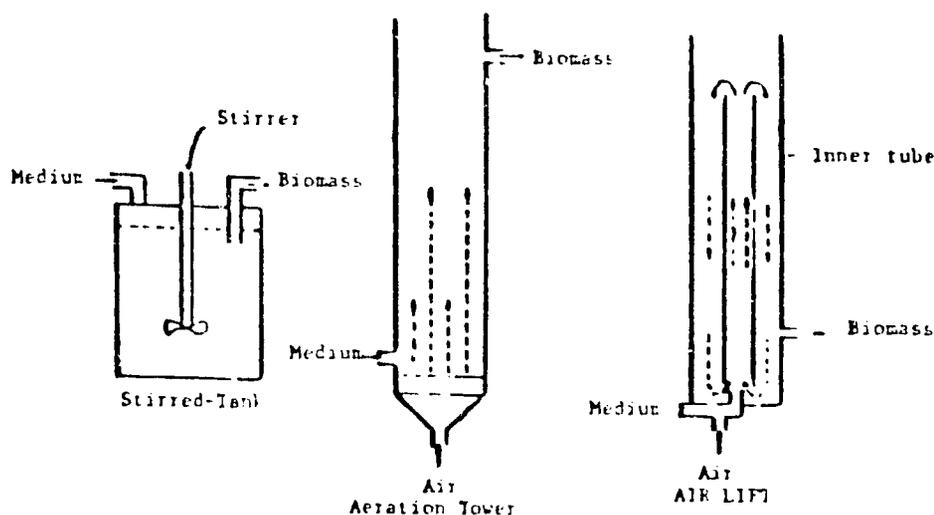
Figure 4.2  
 Provesta Continuous SCP Process  
 (Source Prepared Foods, 1985)



A substantial amount of research in yeast single-cell protein (SCP) production has also been conducted at the University of the Philippines at Los Banos. This research has concentrated on the production of *Candida utilis* on coconut water and molasses (del Rosario, 1980, del Rosario, 1984). These investigations utilized coconut oil as an anti-foam agent and examined the use of the aeration tower and airlift fermentors depicted in Figure 4.3 to achieve high oxygen transfer rates. The best results using coconut water were achieved with the airlift fermenter although the low cell density (25g yeast dry wt/liter) and the non-flocculating properties of the strain employed necessitates centrifugation for yeast recovery. Investigators suggest that the use of a flocculating yeast in a continuous stirred reactor system would probably be preferable for achieving more concentrated aerobic fermentations and for facilitating yeast recovery. Recent achievements in fermenter design have significantly improved the reliability and economics of yeast SCP production systems.

Production costs for yeast SCP are highly variable and depend on the grade of yeast produced (food or feed), the process design and site of fabrication, and the plant configuration (e.g., autonomous or annexed). Investment costs for a 10,000 MT/yr yeast plant range from \$2 million for an annexed facility producing fodder yeast to \$35 million for an autonomous facility producing yeast for human foods. Conversion costs can range from \$100/MT of yeast for an annexed facility using on-site utilities and surplus steam to more than \$400/MT of yeast for an autonomous facility. Minerals and nutrients can cost from virtually nothing up to \$140/MT of yeast. Feedstock could be free, as in the case of stillage, or could cost up to \$178/MT-\$213/MT yeast for cane juice or molasses, respectively (NEDA, 1985). Thus, yeast production cost could range from \$125/MT to \$1,036/MT. With the soybean equivalent value of yeast being roughly \$365/MT of yeast, it appears possible to produce yeast profitably, but the circumstances will have to be carefully designed.

Figure 4.3  
Three General Types of Fermenter Designs



9. Studies at the University of the Philippines at Los Banos showed that raw bagasse had a 20% TDN (Total Digestible Nutrient) compared to a 40% TDN for rice straw (Arboleda, 1986).

10. The term autohydrolysis comes from the fact that the initial event is the hydrolysis by steam of labile (readily-attacked) acetyl moieties in the hemicellulose to release acetic acid. This lowers the pH to 3-4 which is sufficient to catalyze the hydrolysis of sugar linkages in the hemicellulose polymer to water-soluble subunits, thus disrupting the protective matrix (Casebier, 1969). The sudden depressurization of the cooked mash further softens fibrous material by the rapid expansion of gases within the material (Navarro, 1985). In addition to making the cellulose more susceptible to attack by digestive enzymes in the rumen, the pentose (5-carbon) sugars released from the hemicellulose are also digestible by ruminants (Harris, 1958). Table 4.14 below shows properties of raw and hydrolyzed bagasse.

11. Industrial tests through the 1984-85 harvest were carried out by Destilaria Alcedia SA in Brazil. Cattle were fed 1000 tons of balanced ration containing 2/3 hydrolyzed bagasse and 1/3 concentrated feed (protein, minerals, salts). The average live weight gain over the 120-day period was 1-1.2 kg/day at a feed consumption rate of 10.2 kg dry matter/day (Navarro, 1985). Plans were to expand the feeding operation to 3,000 head of cattle for the 1985-86 season.

12. One difference between techniques is that caustic soda must be purchased for the alkali process. The cost of alkali is low (US price: \$205/ton for 73% liquid) and constitutes only 25% of the total cost of the feed. Protein accounts for 35% of the cost and salt, urea, bone meal and other additives constitute 40%. Developers indicate that yeast recovered from a distillery will reduce the cost of protein by

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two-thirds. The total investment for the feed-production system is \$57,750, sized to produce feed for 3,000 animals for a year, with the alkali treatment part of the system costing \$23,000. (Investment costs for steam treatment have not been reported.)

Table 4.14  
Comparison of Raw and Autohydrolyzed Bagasse

<u>Determination</u>	<u>Raw Bagasse</u>	<u>Autohydrolyzed Bagasse</u>
Dry matter (weight %)	48.31	44.32
Raw protein (g/100g dry matter)	1.86	1.86
Raw fiber (%)	45.09	34.45
Cellulose (%)	44.69	43.99
Hemicellulose (%)	22.91	--
Lignin (%)	14.89	15.06
Ether Extract (%)	2.26	4.86
Mineral Matter (%)	2.73	4.77
Non-nitrogenated Extract (%)	48.06	54.25
In-vitro Digestibility of Dry Matter (%)	35.31	64.82
Animal Weight Gain (g/day)	610	1160
Feed consumption rate (kg/day)	7.2	11.8

Source: Navarro, 1985

13. The alkali treatment does not incorporate the rapid depressurization step which further disrupts the lignocellulose when using steam autohydrolysis. However, aqueous alkali will disrupt and begin to dissolve some of the lignin and this will enhance breakdown of the matrix (Koukios, 1983). Unfortunately, product analyses for alkali treated bagasse have not been reported so a direct comparison of the results of steam and alkali treatments is not possible. Weight gains (1 kg or more per day for a 300 kg animal) and intake rates (8 kg dry matter/day for a 300 kg animal) are comparable to those reported for steam-treated bagasse feeding (Unger, 1985). This technique was developed in Brazil by the Usina de Japungu in Paraiba, which now uses the process to feed cattle at a confined feedlot operated by the distillery's parent company, Grupos Agrofertil e Economico.

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14. The conceptual basis behind the effectiveness of techniques to improve the digestibility of bagasse lies in the structure of lignocellulose, which has three components: cellulose, hemicellulose and lignin. Hemicellulose, a complex carbohydrate polymer, and lignin, an equally complex polyphenolic material, are both cross-linked to provide a resistant amorphous (non-crystalline) matrix. The principal constituent, cellulose, is a highly crystalline polymer of the sugar, glucose, whose fibers are embedded in the lignin-hemicellulose matrix. When the matrix is intact, the cellulose is inaccessible to biological attack by enzymes such as those produced by bacteria in a cow's rumen.

Either the hemicellulose or lignin component of the matrix must be degraded to render the cellulose accessible to biological attack. The two principal methods of attacking biopolymers are through hydrolysis using acids or bases, or by oxidation. Hemicellulose (28-40% of bagasse) has proven to be quite susceptible to hydrolytic attack while lignin is much less susceptible. Lignin, however, appears quite susceptible to oxidative attack, as the biodegradation of lignin in nature occurs by way of oxidation. Thus, the effectiveness of new treatments can be anticipated.

15. One organizational approach that may be useful in the Phillipines, in use at the Usina de Japunga in Brazil, is to distribute feed produced at the mill (or distillery) to surrounding small farmers. The distiller supplies feed, calves and marketing services to the surrounding small farmers. The farmers feed the calves to market size and then return the cattle to the distiller for sale. Proceeds are divided between distiller and farmer according to an agreed upon formula (Unger, 1985). In the Phillipines, a coordinated effort between the feed producer and a farmer's cooperative or livestock distribution program may be needed.

16. In 1975, a yeast plant using cane juice was installed in the Island of Leyte for the production of nucleic acid flavor enhancers. The estimated cost of yeast production in this autonomous facility was \$414/MT which is roughly consistent with the lower production cost estimated for an annexed facility. The plant is no longer operating. In Taiwan, yeast produced from molasses, is now used widely in aquaculture feed formulations (DeBaussey, 1986).

In addition, the estimate in Table 4.9 for a feed yeast plant sited in a developing country is consistent with reported production costs for an autonomous yeast from molasses plant recently opened in Brazil by Nabisco. The cost of crude yeast product is \$340/MT in which the investment in utilities, crushing equipment and other infrastructure is included in the capital cost. The cost at an annexed facility would be somewhat less because of existing capital equipment, thus the estimate of \$283/MT for an annexed facility (Nabisco, 1986.).

17. The annexed plant cost estimates are from the Australian firm of Queensland Science and Technology Ltd. The principal savings for the developing country case are in capital cost and utility requirements. Energy requirements for the process are substantial and some electricity will probably have to be purchased from the grid since most mills have limitations in their generating capacity. The bagasse generated in producing the cane juice should meet about 50% of the process heat requirements and there should be sufficient surplus steam available from the mill to meet the remainder.

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18. Whole cane can also be used for fodder feeds; for instance, whole cane could be ensiled, or used in simplified on-farm schemes, or even processed at a sugar mill annex where advantage was taken of excess cane crushing capacity and exhaust steam. This would raise the theoretical potential of cane available in the Philippines for carbohydrate feeds.

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APPENDIX A

A NOTE ON REGIONAL ECONOMIC COMPARATIVE ANALYSIS

## APPENDIX A

### **A Note on Regional Economic Comparative Analysis**

The direct resource cost (DRC) is a measure used in several studies of economic policy and agriculture in the Philippines. DRC is defined as the ratio of domestic costs per unit of a commodity to its price minus foreign costs per unit. The ratio of the DRC to the (shadow) foreign exchange rate (DRC/SER) indicates the efficiency of the commodity in generating foreign exchange. If the ratio is less than 1.0, the commodity has a relative comparative advantage. If the ratio is greater than 1.0, it has a relative comparative disadvantage. To standardize comparison among different production systems, the social profitability (SP) is computed as an index measuring social profit as a percentage of the social value of scarce domestic factors used in production ( $SP = \text{net social product} / \text{domestic factor costs} \times 100$ ).

The private cost ratio (PCR) is a useful measure of private profitability. It is defined as the cost of domestic resources required for every unit of value added. ( $PCR = \text{cost of domestic factors} / \text{total revenue} - \text{cost of traded inputs}$ .) To standardize comparisons among different production systems, the private profitability index (PP) is expressed in terms of private net profit as a percentage of gross revenue or actual market prices ( $PP = \text{net private profit} / \text{gross private returns} \times 100$ ).

L.A. Gonzales has analyzed the economic comparative advantages of major crop and livestock production systems of the Philippines. Tables 6, 7 and 8 of his publication Philippine Agriculture Diversification: A Regional Economic Comparative Advantage Analysis are reproduced on the following page to illustrate the results of the analysis with respect to one of the crops studied.

Table 6

## RANKING OF THE PRIVATE PROFITABILITY (%) OF RICE PRODUCTION SYSTEMS BY REGION, PHILIPPINES, 1983.

PRODUCTION SYSTEMS	R E G I O N S											
	I PP Rank	II PP Rank	III PP Rank	IV PP Rank	V PP Rank	VI PP Rank	VII PP Rank	VIII PP Rank	IX PP Rank	X PP Rank	XI PP Rank	XII PP Rank
PS1: Rainfed upland, mechanized				14								
PS2: Rainfed upland, non-mechanized		-88			-11		6		30 8		6	
PS3: Rainfed lowland, mechanized								11		47 1	-20	
PS4: Rainfed lowland, non-mechanized	20	37 4			14	15	12		29 9	36 5		
PS5: Irrigated, mechanized	26	41 2				21	27		39 3	34 6	30 8	12
PS6: Irrigated, non-mechanized	24	31 7			6	26	20	0.7	34 6	25	28 10	-59

SOURCE: Gonzales, L. A., Philippine Agricultural Diversification: A Regional Economic Comparative Analysis, 1984.

Table 7

## DOMESTIC RESOURCES COST (DRC) AND COMPARATIVE ADVANTAGE OF RICE PRODUCTION, BY TYPE OF SYSTEM, BY REGION, PHILIPPINES, 1983.

PROJECT SYSTEMS	R E G I O N S																							
	I		II		III		IV		V		VI		VII		VIII		IX		X		XI		XII	
	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC	DRC
	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER	SER
PS1: Rainfed upland, mechanized					7.2	0.43															5.7	0.34		
PS2: Rainfed upland, non-mechanized			15.3	0.91	9.7	0.58				9.1	0.54	6.2	0.37			8.5	0.31							
PS3: Rainfed lowland, mechanized														7.0	0.42			5.4	0.32					
PS4: Rainfed lowland, non-mechanized	7.1	0.42	6.3	0.37	8.4	0.50	8.4	0.50	7.1	0.42	7.8	0.46				6.4	0.38	5.8	0.34	6.5	0.39	8.40	0.50	
PS5: Irrigated, mechanized	7.4	0.44	6.2	0.37					7.3	0.43				9.3	0.55	6.7	0.40	6.7	0.40	7.1	0.42	12.9	0.77	
PS6: Irrigated, non-mechanized	7.7	0.46	7.9	0.47	8.9	0.53	8.9	0.53	7.5	0.45	7.5	0.45	10.3	0.61	6.4	0.38	7.3	0.43						

SOURCE: Gonzales, L. A., Philippine Agricultural Diversification: A Regional Economic Comparative Analysis, 1984.

Table 8

## RANKING OF THE SOCIAL PROFITABILITY (%) OF RICE PRODUCTION SYSTEMS BY REGION, PHILIPPINES, 1983

PROJECT SYSTEMS	R E G I O N S											
	<u>I</u> SP Rank	<u>II</u> SP Rank	<u>III</u> SP Rank	<u>IV</u> SP Rank	<u>V</u> SP Rank	<u>VI</u> SP Rank	<u>VII</u> SP Rank	<u>VIII</u> SP Rank	<u>IX</u> SP Rank	<u>X</u> PP Rank	<u>XI</u> PP Rank	<u>XII</u> PP Rank
PS1: Rainfed upland, mechanized				96								
PS2: Rainfed upland, non-mechanized		-8			44		54		127 4		44 2	
PS3: Rainfed lowland, mechanized	98							98		162 1	67	
PS4: Rainfed lowland, non-mechanized		123 6			66	96	80		117 7	143 3		
PS5: Irrigated, mechanized	88	126 5				92	51		108 10	109 9	114 8	67
PS6: Irrigated, non-mechanized	82	76			57	87	87	36	117 7	97	97	6

SOURCE: Gonzales, L. A., Philippine Agricultural Diversification: A Regional Economic Comparative Analysis, 1984.

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APPENDIX B

INFRASTRUCTURE AND MARKET FACTORS  
FOR NEW AGRO-INDUSTRY VENTURES

## Appendix B

### **Infrastructure and Market Factors For New Agro-Industry Ventures**

Following are examples of the kinds of infrastructural factors and market system considerations upon which commercial success for new agro-industry enterprises depends:

1. Roads - Access and transport; conditions and distances to processing/storage sites.
2. Rail terminal points - Frequency and regularity of service.
3. Potable water availability - Re: packing/processing operations.
4. Electric power availability.
5. Ports - Proximity to air/ship ports; frequency and regularity of service; port fees; cargo capacity of planes/vessels available; days to marketplace; level of 'baksheesh' required to store, handle and move goods through port facilities.
6. Availability of shipping containers - Refrigerated and dry; power sources for refrigerated container; opportunity for container backhaul utilization.
7. Repair and maintenance - Capabilities available to service agricultural, trucking and packing/processing equipment; level of expertise of available tradesmen (mechanics, electricians, welders).
8. Spare parts availability - Customs regulations, duties; delivery time.
9. Sources and availability of any special fuels and lubricants.
10. Sources of packing materials and packaging - Boxes, tinsplate, liners cost to imports vs local manufacture.
11. Availability of markets for by-products.
12. Seed sources or availability of nursery stock, or ability to establish propagation operations.
13. Government quality standards for products - Level of government inspection and enforcement.

## Appendix B

14. Availability of tax and other incentives for agribusiness investors.
15. Extension services provided.
16. Commodity marketing or prevailing brokerage system and how organized; seasonality and price trends; marketing system organization and operation.
17. Producers' access to market intelligence information (supply, demand, price, and trends) for intended export markets.

APPENDIX C

RECOMMENDATIONS WITH RESPECT TO CREATION OF A SUGARLAND  
DEVELOPMENT COMMISSION AND SECRETARIAT  
TO STIMULATE INVESTMENT IN NEW CROP VENTURES AND TO ASSIST  
COMMUNITIES FACED WITH FORCED CROP SUBSTITUTION  
DUE TO MILL CLOSURES

## Appendix C

### **Recommendations with Respect to Creation of a Sugarland Development Commission and Secretariat to Stimulate Investment in New Crop Ventures and to Assist Communities Faced with Forced Crop Substitution due to Mill Closures**

Due to the extreme urgency resulting from currently high unemployment and underemployment in rural areas, the sharp adverse impact that additional mill closings are likely to have on already depressed sugar producing regions, and the need to expedite economic development in order to strengthen the country's generally weak economy, the study team suggests that an organization - a task force or commission, assisted by a secretariat - be established for the specific purpose of facilitating new and/or expanded agribusiness development. Sugar growers, large and small, seem sincerely interested in exploring new crop opportunities, and appear willing to secure and invest capital to accomplish this goal.

However, many of the growers, their cooperatives, and commercial packers and processors are not convinced that key government agencies and ministries are prepared to make the necessary supportive commitment to develop expanded agroindustry. Farmers in the Philippines are no different from their counterparts in other countries. They are pragmatic, realistic, and unlikely to make bold initiatives involving the commitment of resources where they perceive a high degree of risk and/or a lack of commitment on the part of government and the public sector in support of those initiatives.

The establishment of an organization to facilitate crop diversification ventures would be an initial demonstration of the government's firm commitment to successfully develop the agricultural sector of the economy. The organization would serve two basic purposes: 1) to promote and assist new agricultural investments; and, 2) to identify communities needing special priority attention.

If successful, such a commission would: 1) increase gross revenues from agricultural products; 2) increase the number of jobs in depressed regions; 3) diversify the agricultural economy; 4) stimulate secondary and peripheral (supporting) industries; 5) promote social and political stability.

The organization we recommend (Sugarlands Development Commission) should probably be both temporary (5 years) and independent of existing ministries, reporting directly to the President. The Commission's responsibilities should include:

1. Identification and promotion of diversification and substitution projects/ventures that are implementable on a commercial basis under existing incentives and government policies.

## Appendix C

2. Identification and promotion of projects/ventures which would yield commercial and social benefits, but which require additional incentives and policy support.
3. Performance of economic and technical evaluations for proposed new projects and ventures; analysis of site alternatives; development of proposed operating concepts; conduct of market research and planning.
4. Provision of assistance in drafting bankable business plans; limited technical assistance, where needed, to get projects started; assistance in obtaining government clearances and permits; and general facilitation for the development and/or expansion of ventures.
5. Provision of equity loans and/or partial (limited) guarantees where viable projects have elements of venture capital requirements, and where commercial financing has been refused or is otherwise not obtainable.
6. Counsel to the government in establishing policies and programs to accelerate the sugar lands' economic development process.
7. Establishment of Community Task Forces in critical locations requiring special attention.

We suggested the following as a possible implementation program:

- A. Establish a small, effective commission or task force composed of key ministers and representatives of the sugar industry (including small as well as large growers) who have political influence and a high degree of professional competence and who would report directly to the President.
- B. Appoint an Executive Director and a Secretariat to carry out the work of the Commission, and to administer a reasonable initial operating budget.
- C. Set forth quantitative objectives and draw up a system of priorities for development.
- D. Formulate a development strategy, with the application of sound economic parameters to evaluate project/venture alternatives. Initiate programs to promote private investment. Strategy could include:
  1. Analysis of resources and constraints to economic development in sugarland areas.
  2. Evaluation of markets, both domestic and export. Identification of comparative advantages.

3. Performance of prefeasibility analyses for proposed ventures to determine commercial viability.
4. Coordination of private capital, investors and entrepreneurs for feasible ventures.
5. Coordination of export product development projects with foreign market promotion/intelligence and trade mission offices.

The "Sugarlands Development Commission" would be responsible for identifying areas requiring assistance in planning and implementing diversification programs. The Commission would also work with regional and provincial governments in creating local Community Task Forces to assist those communities. These local task forces should include staff from the extension, research and other government development agencies as well as local commercial, banking and community leaders. These would be truly "local" task forces, but the Sugarlands Development Commission would provide technical guidance and financial support, coordinating with regional and provincial governments.

Principal functions of these Community Task Forces would include: 1) assessment of local physical and human resources, adjustment problems and production opportunities; 2) identification of the most promising crops and production technologies, testing of their technical and economic feasibilities and demonstration of their validity as potential alternatives to sugar production; 3) identification of deficiencies in infrastructure and constraints in support services for these crops or products to be successful; 4) determination of requirements for external technical and financial assistance; and 5) planning and organizing promotional programs for implementation of adjustments.

APPENDIX D

OUTLINE FOR CHARACTERIZATION OF BEEF CATTLE INDUSTRY

## APPENDIX D

### Outline for Characterization of Beef Cattle Industry

- A. Marketing information for primary products
  - 1. Spatial and temporal demand for animal products.
  - 2. Estimated profitability of domestic sales.
  - 3. Transportation.
  - 4. Quality assurance.
  - 5. Wholesale and retail marketing methods.
  - 6. Rural accumulation systems and auction sales.
  - 7. Distribution and sale of feeder cattle.
  
- B. Processing capabilities.
  - 1. Locations and capacities
  - 2. Utilization of secondary products - horns, hide, hooves, bones, offal.
  
- C. Production Formation
  - 1. Appropriate breeds for nucleus herds.
  - 2. Breeding (crossing) strategies for production of feeder cattle.
  - 3. Nutrition at optimal or sub-optimal levels.
    - a. Sources of feed and composition of rations.
    - b. Field production systems, e.g. extended or confined pasture, feed
  
- D. Animal health problems and solutions.