THE SCOPE FOR THE UTILISATION OF INDUSTRIAL AND AGRICULTURAL BY-PRODUCTS

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Introduction

The efficient utilization of by-products is the sign of a successful industrial processing operation and indeed for many industries, by-product utilization constitute the difference between red and black in their Profit and Loss statements. In fact, it would be stated that the hallmark of a successful industry exploiting its raw materials to the fullest is the impossibility of distinguishing main-line operations from spin-offs. Good examples of industries which illustrate the principle of efficient by-product utilization would include the Danish pig and pork industry and the petroleum industry.

The Caribbean Situation

General

Here in the Caribbean, by-product utilization is an accepted feature of certain industries, though this does not imply efficiency of use nor does it imply that the scope has been exhausted. Traditional examples are found in the sugar industry where the production of rum is an established aspect of our economies. The oil sector also shows some degree of by-product utilization even though the main-line operations locally include the production of fuels and lubricants while intermediates are exported to metropolitan countries for the more lucrative and more sophisticated petrochemical processing. More recent examples of industrial spin-offs are the production of particle-board from bagasse, the production of wheat middlings for animal feeds from wheat milling operations, the manufacture of citrus meal from citrus price operations and the production of spent brewer's grain from the brewery industry as an input into animal feed formulations.

Generally speaking, however, the situation here in the Caribbean as indeed in the rest of the Third World is woefully lacking in examples of successful commercial spin-offs. There are many reasons for this but this will be taken up later on when the issue of problems and possible solutions is raised.

The Potential for By-Product Utilization

The questions that must be asked at this stage of the game are: *Is there any potential for the utilization of agricultural and industrial by-products and if so, what is the scope that exists?* To answer these questions comprehensively, all sorts of *ifs* and *maybes* would have to be delved into and this could become very lengthy. It would be wise, therefore, to limit ourselves to that which we have now that could be more fully and relatively easily exploited.

The question of by-products immediately conjures up the fact of waste and because of an abhorrence to see potentially useful material going to waste,

people tend to become very optimistic about what exists and what can be done. By-products by virtue of being by-product in the first place tend to receive inadequate handling and so quality is often suspect. Secondly, people easily over-quantify how much by-product is available. One must realise that if one is going to establish an industry to capitalize on an available raw material, there are three basic criteria that must be fulfilled:

(a) the quality of the material must be such that it will produce end-products with the required performance characteristics - you cannot expect to start off with a low grade raw material and hope to finish off with best quality end-products;
(b) the quality of the material must be such that the plant can be assured of a constant supply during operations; and
(c) the material must be available at the right price though it is necessary to add that in the protected economies here in the Caribbean, the question of right price becomes one of right for whom?

What are the existing industries and/or sectors which provide products and/or by-products for further processing? If we think in terms of the three criteria enunciated previously, i.e., quality, quantity and price, the traditional agricultural sector immediately fits the bill and sugar cane becomes a prime area for discussion.

The Traditional Agricultural Sector

Sugar Cane: For all its evils, apparent and otherwise, sugar cane is a crop to which we have devoted nearly 300 years of history and one which we know and understand in the Caribbean. In the course of history it has almost become synonymous with the Caribbean and after all is said and done, it is still the most efficient converter of solar energy into chemical energy. It is therefore a crop whose diversification and further processing should have been occupying our minds for the longest while instead of the single-mindedness of raw sugar production which we have been pursuing up till now. Of course we produce rum and of late particle-board but what of the magnitude of other products which we could and should be producing?

First of all, let us look at the industry as it is now structured before we consider new ideas like cane separation, i.e., the Comfith Process. Is it wise that in 1974 we in the Caribbean should still be thinking in terms of exporting crude raw sugar and molasses? We should be exporting refined sugar, castor sugar, icing sugar and a whole host of manufactured sugar products so that the value added accrues to us rather than to someone in the U.K. or elsewhere. A sugar worker in the fields of the Caribbean should not be *scrunting* while his counterpart who helps to refine the very sugar that he sweated in the sun to produce lives a decent life in Liverpool. Does the Caribbean sugar worker work any less hard and if not, does he deserve any less for his toil and his sweat?

The technology for refining sugar or manufactured sugar products is no *big deal* and for every one sugar worker who toils to produce one ton of raw sugar, at best 10 and possibly more find work in the metropolitan country to convert this raw sugar into the myriad of products which we

subsequently import at exorbitant prices. Let us stop thinking in terms or running off to the U.K. every few years or so to beg guaranteed prices for our raw sugar at the Imperial Sugar Conference and let us instead channel our energies into the more efficient utilization of our raw sugar. And let us not be the bogey of cheap beet sugar or allow the magic of technology fool and misguide us.

Molasses used to be a sore point in our sugar industry. Up to about a year ago, you couldn't even give away the stuff. Now the market for molasses is buoyant. So much so that comments have been heard to the effect that we should cease the manufacture of sugar and just export molasses. But should we? What is the fate of this molasses which we are exporting? First of all, a large part of it is mixed into animal feed rations especially in cattle feed lots across Canada and the U.S. Secondly, a lot of it goes into fermentation industries by people like Pfizer and Miles who produce chemicals like citric acid. The cycle then makes a full turn because then we import beef, dairy products and citric acid for our food processing and soft drink industries. Can we not raise animals in feedlots down here based on the same molasses as a carbohydrate source and then we export the beef and the dairy products? Can we not keep our molasses which is bulky and expensive to ship anyway, and ferment it to citric acid which is expensive and more amenable to shipping?

In these days of the energy crisis and the high cost of petroleum products, we must consider molasses as a substrate for two further products. One is industrial alcohol, a process that is basically similar to the manufacture of rum. Production of industrial ethanol by fermentation of carbohydrate materials like molasses has long been marginally competitive with synthetic alcohol from the petrochemical sector. Now the situation is changed. Fermentation alcohol is competitive and this alcohol is an indispensable chemical in its own right not only as an industrial solvent but also as a raw material for chemical synthesis and also as a fuel additive. Molasses constitutes a prime fermentation raw material for alcohol production and a substantial market for fermentation alcohol will exist for the foreseeable future. We need to be getting into the act now.

The other product which must be considered as a fermentation by-product of molasses is single-cell-protein (SCP), i.e. the actual bacteria of yeast which ferments the molasses. These organisms can be harvested, e.g. spent brewer's grain, and constitute an excellent protein source not only for animal feeding but also directly for human nutrition. In fact the Lord Rank Research Centre in the U.K. has developed this SCP from molasses as a human food and they have just teamed up with de Pont of the U.S. to bring the process to exploitation.

And finally there is bagasse. Another raw material that could be channelled into animal feeds, the production of furfural which is an important chemical used in lubricants, and even as a substrate for SCP production.

The cane separation or Comfith process deserves some mention here because of the fact that it offers ease of diversification and a new approach to the utilization of sugar cane. Comfith offers us a stock feed, a material from which we can make white sugar from the outset and

it also offers us the rind to be used in board production and as a building material.

All told, sugar cane is still an exciting crop with an exciting future but we must not miss the boat.

The Other Plantation Crops: The situation in respect of the other traditional plantation crops is no better. We are still gross exporters of raw cocoa and coffee beans and still gross importers of processed cocoa and coffee products. It must be appreciated that the value added occurs during processing into finished products. This has been largely responsible for the developments of Western European countries. The Arabs and oil have taught us a lesson which we should not and must not forget. We in plantation economies must treat our agricultural raw materials the way that the Arabs treat their mineral resources. We must not be content to export at low prices and import at high prices thereby subsidising a foreign economy to the detriment of our *scrunting* populations.

The New Sectors

Animal Feeds: The question of animal feeds is a burning one for us in the Caribbean. The high cost of meat, meat products and dairy products is directly attributable to the high cost of imported feed-stuffs. This has stifled the growth of the industry and led to our dependence on imports. But what really are the constraints to our developing animal feeds based on local materials? It has always been claimed that we in the Caribbean have no raw materials of the right quality and quantity to warrant investigation. But the real fact of the matter is that this explanation has been handed out to us so much that we now believe it ourselves.

An animal feed consists basically of carbohydrate, protein and various supplements. Ruminants, e.g. cattle, are slightly different in that they can synthesize protein if they are fed non-protein nitrogen, e.g. in the form of urea.

The carbohydrate aspect of the feed has traditionally been supplied by corn. But this has only been because temperate countries can grow corn and not cane. Had they been able to grow cane, the story might have been different. But we in the Caribbean, because we never initiate, all we do is beg, borrow or copy, we believe the corn is the be-all and end-all to the supply of carbohydrate in animal feeds. It seems that we have seriously tought of cane as being able to provide the carbohydrate. We have molasses, bagasse, Comfith: all we need now is will and effort.

Secondly, we have the protein aspect of the feed. This is supplied by imported fish meal and soybean meal. Efforts are now being made to grow soybean on a large scale in the Caribbean. Is this wise? Do we have the necessary acreages and agronomic skills? Is soybean the best choice or should it be sunflower or sesame or peanut? And what of fish meal? Can we make it in the Caribbean? The answer is yes but we must tread carefully. Certainly the major part of the Caribbean enjoys beautiful water for swimming and it is an unfortunate fact that seas for swimming and seas for supporting large fish populations are not compatible. The water in the Caribbean has originated off the coast of S.W. Africa and in its long

journey across the Atlantic it gets depleted of all its plantation. Result - no food for fish - therefore no fish. But the answer may lie in Guyana and Trinidad. In the stretch of water between Trinidad and Tobago and Guyana, the so-called Guyana Banks, there is a large outflow of fresh water carrying important ingredients into the sea. This stimulates the growth of plankton hence the murky water, and this attracts fish and shrimps. It is unfortunate for us that the Banks are only being shrimped and not fished because there is a rich harvest of fish being dumped. The trawlers operating out of Trinidad and Tobago, Guyana and Surinam, during their shrimp trawling operations haul in both shrimp and fish but the fish is thrown back overboard and the precious shrimp retained. After all the shrimp is $2(US) per pound, the fish might only fetch five cents if so much. So the attitude has been go after the shrimp, forget the fish.

However, if we look at the figures, then we see the magnitude of the problem. There are about 400 trawlers operating on the Bank and a normal trawl will yield about 15 per cent shrimp and 85 per cent fish. Each trawler lands an average of 100,000 pounds of shrimp per annum. That means that each trawler dumps overboard about 65,000 pounds of shrimp heads and about 935,000 pounds of fish, i.e. about 1×10^6 pounds of waste per annum. Multiply that by the 400 boats on the bank and one gets the colossal figure of 400×10^6 pounds of waste, i.e. about 200,000 tons per annum. Not for one moment is this to be taken as a suggestion that all this be converted to fish meal as a large part of this is perfectly acceptable and edible fish and should in fact find its way to the consumer as a fish or fish product. After all, the 15 West Indian territories import the equivalent of about 200,000 tons fish per annum and a large part of this could be filled by the fish from the Banks. Fish meal is a terribly inefficient way of converting an animal protein into human protein. Nevertheless, if we allow for these vagaries of the human diet, if all this waste from the Guyana Banks were converted to fish meal, we would end up with about 50,000 tons of fish meal which at any rate is just under what we require in the Caribbean.

In addition to this aspect, there is another problem on the Banks. The dumping of all this waste attracts the scavengers, i.e. the sharks and the catfish and when these move in, the shrimp move out. So we could be killing the goose that lays the golden egg. But then most of the trawlers operating on the Banks are not West Indian. They are Japanese or U.S. or British, so what do they care anyway? Once they have amortised their equipment and made their profits, they move on. We then have to pick up the pieces.

It must not be misunderstood that the solution to the problem is easy. But what is being said is that there is a solution and it is up to us to find the optimal answer to the problem.

The second facet to the solution of the protein problem is SCP. SCP is simply the harvested cells of micro-organisms which have been dried to a powder. This may be extruded, spun and textured to produce what we call simulated meat products. The latter, however, is meant for human use. For animal use, SCP is formulated as a powder. Any substrate that will supply energy and carbon can act as the base for SCP production. Molasses has already been mentioned, also bagasse

starchy materials, and of recent times petroleum substrates and municipal waste may be used. CARIRI is now in fact doing a study for the Government of Trinidad and Tobago on the feasibility of producing SCP from a petroleum import which may be either natural gas via methanol or gas oil or paraffins. The study is beginning to indicate a plant size of about 100,000 tons per annum and if this is so, it will easily supply the protein requirements for animal feeds in the Caribbean with a surplus for export. The capital investment will be high but the benefits to be derived will be enormous.

We have not looked at the utilization of municipal waste but this is an area we hope to get down to in the future. We do know that a considerable amount of work has already been done in this area particularly in the U.S. and that the processes appear viable.

The final area that needs to be mentioned regarding the production of high protein material for animal feeds is rendered animal waste. The industry which particularly comes to mind is the broiler industry which is now an established industry throughout the Caribbean. Chicken litter, for instance, which is now thrown away and constitutes a disposal problem is high in crude protein (30 per cent) and if dried, cleaned and hammer-milled is an ideal material for incorporation into animal feeds. The use of feathers for the production of protein-rich feather meal is another area where we have the capacity to produce a local animal feed input. Feather meal carries a crude protein of 86 per cent and is a useful adjunct in pig and poultry rations. In fact, we now import feather meal for our animal feed formulations.

The rendering of offal is carried out to some extent but as yet the industry does not process all the offal available and this is another useful source of animal feed inputs.

Packaging Materials: An area which must be briefly touched concerns packaging materials. At the moment, we are using increasing amounts of packaging materials all being imported at considerable cost to us. However, none of this material is being recycled - all of it simply goes to waste. We are also importing considerable amounts of newsprint, again all of it goes to waste after use.

One of the areas which we are looking at is the use of waste paper and particularly newsprint in the manufacture primarily of egg boxes and secondarily of other forms e.g. trays. The equipment for egg-box manufacture based on paper or pulp is high speed equipment whose cost is astronomical. We have located a recent development of an intermediate technology associated with egg-box manufacture based on waste newsprint. The equipment is ideally suited to our needs in that it is relatively low speed and comparatively inexpensive. This is an example of by-product utilization which makes good sense in very many ways.

Another area that we are investigating is the recycling of wrapping paper, old cartons, paper bags, tec. Such paper can easily be converted again with relatively simple and inexpensive technology

to produce paper of higher grammage which could again be channelled into wrapping paper, paper bags and such material could be recycled again and again. With the present high cost of paper and the long term shortage of paper products that is forecast, such recycling of what is an imported commodity makes a great deal of good sense.

Something that could be of tremendous interest to those areas which grow bananas on a large scale is the technology developed and perfected by the Indians using the leaf bases of the banana to produce a cushioning material in packaging that has superior characteristics to corrugated board. This banana material is now used by the Indians for many of their delicate export items. In the banana material, the corrugations run in more than one direction so that it is multi-directional thereby producing greater cushioning against shock. It is indeed no quirk or fate that the delicate stem of the banana plant is protected by such material.

The Problems and Possible Solutions

It must be evident that the scope exists for us here in the Caribbean to develop and expand the ways in which we utilize our raw materials and their by-products. The examples presented here were simply meant to illustrate certain points and were not intended to be exhaustive. We must however be cognizant of the existence of certain problems and take steps to solve these problems.

An urgent problem that needs to be tackled is the need for a lot more indigenous research and development. It is no accident that the developed countries spend a greater proportion of their national budgets on research and development than the developing countries. The extreme case is represented by the U.S.A. where 3 per cent of Gross National Product is spent on research and development. Corresponding figures for Japan are 1.5 per cent and West Europe 2.3 per cent. This may be compared with the situation in Trinidad and Tobago or in Jamaica where the respective figures are 0.24 and 0.11 per cent.

We cannot depend on overseas laboratories or institutes to solve our problems. They have their own problems as well as their own criteria of determining what is the optimal solution to any problem and this may not necessarily coincide with our optimal solutions. We must learn to solve our problems in our environments using our trained personnel. This means that we must have a bigger core of trained and competent manpower on which we can call, that we must have adequate facilities, and that we must have faith in the competence of our trained personnel. These research and development efforts must not be aimed solely at product development, but must also look at process development, technology adaptation and innovation, and at design and fabrication wherever possible. In other words, the approach needs to be bold, fresh and innovative.

This paper also suggests that in our search for technology, we must not be restrictive in our thinking or accept the first technology that comes our way. We need to search out all the available technology, to study it and understand it so that we may be better able to select a technology that is appropriate to our needs. Knowledge about the

technology and the existence of alternative technologies place us in a better bargaining position once we start to negotiate a technology transfer.

Finally, we need to develop the will, the attitude of mind and the incorruptibility that would enable us to evaluate situations rationally and make decisions honestly and for the benefit of all of us here in the Caribbean.