POTENTIAL FOR AGRIBUSINESS IN FEED MANUFACTURE UTILIZING INDIGENOUS RESOURCES IN THE CARIBBEAN

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Rationale for Development of the Livestock Sector Through Indigenous Feed Manufacture

Deficiency of Animal Protein Supply

The Caribbean Region has so far not been able to produce the animal protein required to meet the dietary needs of its people. In fact the statistics (Table 1) show a wide gap between demand and production. For example, the Regional Food and Nutrition Strategy (RFNS) projected that in 1980 the Caricom Demand for livestock products including beef, veal, mutton, lamb, pork, poultry, eggs and milk was 434 tonnes. Production in 1981, (ECLA, 1982) one year later, was only 50 per cent of this level. The 1985 projected demand is 545 metric tons (Caricom, 1980) which is approximately 2.5 times the level of production in 1981. It should be noted, however, that although individual territories may be self-sufficient in some commodities, the Region as a whole is deficient in each category of protein source referred to.

TABLE 1: Demand and Production of Protein from Animal Sources in Caricom

Products	*Total Demand Projected* (000 MT) 1985*	*Projected in 1981** (000 MT)*
Beef & veal	*76*	*18*
Pork	*34.5*	*14*
Mutton & lamb	*13.2*	*0.25*
Poultry	*120.9*	*75*
Table eggs	*41.7*	*14.4*
Milk	*259.1*	*91*
Total	*545*	*212.65*

Sources: * Caricom, 1980
**ECLA, 1982

Reliance on Imported Feed Ingredients

While there is evidence of programmes and projects in some countries to increase production to fill the gap, and meet at least the national needs, a significant constraint in this task is the limitations which are imposed by the land resource availability, particularly for ruminants. Notable exceptions are, of course, Guyana and Belize. However, for many of the Region's territories, their small land masses characterised by rugged terrain over significant proportions of the land area result in intense competition for usable land from the various land-based economic activities. Consequently, attempts to improve animal production and productivity in many countries have tended to rely upon systems of production imported from the developed countries including the feed ingredients

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commonly used in those systems. The result has been a heavy dependence of much of the Region's livestock sector on imported feeds and feed ingredients.

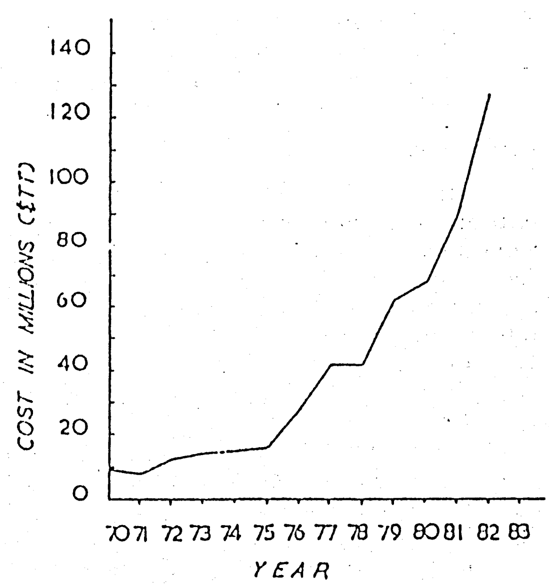
The above is of course associated with a number of adverse implications which, even the most endowed states, cannot afford: for example, the reliance on foreign exchange together with the attendant problem of balance of payment difficulties which many of our countries face. Dependence on foreign sources of feed may also introduce problems relating to feed prices, feed quality and security of supply.

Defining Appropriate Animal Production Systems

The Region's livestock sector obviously needs to be more self-reliant in the provision of its feed requirements. It is also evident that in an effort to increase production and productivity from its most limiting physical resource, land, this sector needs to adopt more appropriate production systems.

For example, the feed import bill for Trinidad and Tobago rose from \$9 x 10^6 in 1970 to \$127 x 10^6 in 1982 (Figure 1). Whereas (Table 2) the physical quantities increased from 59,033 to 97,519 tonnes over the period 1971-78. The heavy reliance on imported material is reflected in the fact that in 1981 this constituted 129 per cent of the total subsidised price of feed manufactured locally. The major feeds and feed ingredients usually imported are corn, oilseed cakes (mainly soyabean), mixed grains, and bone meals and other prepared feeds. In 1978, 72,567 tonnes of corn valued at \$27.1m were imported and 23,660 tonnes of soyabean valued \$17m were also imported. These constituted 40.0 and 25.0 per cent, respectively of the feed import bill.

FIGURE 1:
The Feed Import Bill of Trinidad & Tobago, 1970-82



Source: MALFP, Trinidad & Tobago

TABLE 2: Imports of Major Feed Ingredients for Selected Years in Trinidad and Tobago

Ingredients	*1971*	*1973*	*1975*	*1978*
	Quantity imported ('000 kg.)			
Maize (corn)	42,627	27,301	77,950	72,567
Cereal by-products	640	499	-	-
Oilseed cakes & meals	8,851	9,777	19,210	23,660
Commercially mixed meals	2,018	1,768	377	868
Bone meal & other prepared animal feeds	4,897	3,365	625	424

Source: C.S.O., Trinidad & Tobago.

Appropriate production systems in this context are systems which maximize domestic animal production subject to the following considerations:-

1. land resource supply;
2. availability of indigenous feedstuffs derived from existing food and fiber systems e.g. rice production, sugar production, root crop production and banana production;

3. foreign exchange supply and conservation goals;
4. production of high quality feed of consistent quality;
5. an overall policy objective to be self-reliant.

Objectives

In an effort, therefore, to explore the various possibilities in the Caribbean for commercial feed manufacture from indigenous resources, this paper aims at the following:

1. characterization of existing animal production systems in the Region;
2. definition of the parameters for a new approach to animal feed development;
3. identification of potentially viable local feed ingredients and commercially available processing technologies.

Characteristics of Existing Production Systems

The Traditional System

Two major ruminant feeding systems can be identified in the Caribbean Region. These systems and their variants have evolved over the years in response to the changing economic fortunes. One is the traditional grass-based system where animals are grazed, tethered or fed using the cut-and-carry method. The other is the *adopted* system in which heavy concentrate use has led to the de-emphasis of pasture development and utilization.

The traditional system is characterized by the following:

1. it is usually extensive either in conventional pasture nomenclature or by virtue of the expanse of the catchment area from which forages are harvested/gathered for the animals;
2. the productivity of the animals is influenced by a number of underlying factors which include:
   (a) the species of forages fed;
   (b) the stage of maturity at feeding;
   (c) dry matter availability and intake.

   The above tends to be highly variable affecting nutrient supply and consequently adversely impacts on animal performance.
3. Limitation of the scope for increasing production by land resource supply and/or the availability of secondary and diminishing miscellaneous pasture resources; as an enterprise this system is less profitable per unit of land when compared with intensive crop agriculture. Of course, it could be argued that pasture lands may be marginal lands not usually suited to crop production except at very high levels of costly soil amelioration.
4. Minimal or non-existent of supplemental feeding cost;
5. Fixity of land and labour resources in most countries cause the productivity per unit of these factors to be low. Accordingly, the traditional system continues to hold sway in countries like Guyana and Belize.

The Adopted System

The adopted system combines conventional grazing with varying levels of concentrate supplement feeding. It is characterized by:

1. foreign exchange dependence because of imported source of concentrates;
2. lack of security of supply and consistency of feed quality;
3. higher levels of animal performance relative to the traditional system;
4. more consistent performance than in the traditional system.

This system may be desirable in countries where land is extremely limited and where no indigenous feed resources are available for processing. In countries where it has been adopted and there is available pasture resources, the introduction of this system may militate against pasture resource development, particularly where price distortions are imposed through subsidies on concentrates.

Defining the Parameters for a New Approach

The Options

Efforts to increase production and productivity in the livestock sector must address those factors of production which can be modified to effect such a change. Given that the land resource base is fixed, and demand for this resource has been increasing at rapid rates in recent years, there is little opportunity for expansion of production from increases in the availability of this factor of production. Similarly, no significant modifications are expected in livestock genetic material in the immediate future which may make appreciable improvements in production and productivity.

It therefore seems that development of the livestock sector has to proceed through the increase availability of suitable feeds/feed supplements from local raw materials. One option is through pasture improvement. But this paper focuses on the development of feed resources from other indigenous materials. Among the necessary conditions for viable commercial manufacture of such feeds from indigenous raw materials are:

1. a reliable and adequate supply of these raw materials;
2. practical and economical conditions of procurement; and
3. raw materials amenable to ready and economic processing into feeds.

Further, a primary requirement for such feeds to constitute commercially viable enterprises is that they should increase production and productivity over the traditional system of production. Additionally, any system of animal production developed on the basis of these feeds should generate greater social benefits than the adopted system which is heavily reliant on imported ingriedients.

Traditional Processing Requirements

The present feed manufacturing industry utilises traditional preprocessed and durable imported feed ingredients. The principal unit operations for complete feed manufacture are grinding, mixing, pelleting and packaging. Any attempt to substitute locally available agricultural raw materials for these traditional constituents presents a new dimension to conventional feed manufacturing. For example, one consideration is the fact that local raw materials must be processed into new forms that are compatible with the requirements of the present conventional feed mills.

Preprocessing of local raw materials must entail a number of changes in product form prior to feed manufacture. These include:

1. freedom from any undesirable nutritional characteristics or constituents and from extraneous matter;
2. durability; so that no appreciable changes in quality occur during storage;
3. transformation of its natural physical form so as to enhance its ability to be handled, transported, stored, ground, conveyed and mixed with other ingredients.

These product characteristics, depending upon the raw material, could be achieved through such unit operations as washing, peeling; size reduction such as chopping, slicing and dicing, drying, chemical admixture and pelleting. Such preprocessed, stable, local agricultural produce and other raw materials may then find wide acceptance by the conventional feed mills, for their later incorporation into compound feeds.

Considerations for Equipment Selection

The selection of equipment for such preprocessing must take into account the following considerations:

1. functional features, specifically the ability to handle local material;
2. the past performance, applications and present usage of such equipment;
3. plant capacity commensurate with the raw material supply levels;
4. investment and operation costs;
5. compatibility of technologies with managerial and engineering capabilities for operations and maintenance;
6. reliability of supply of specialized components to ensure programmed operations;
7. possibilities for local fabrications of certain plant components.

Noting the above, and the need to produce non-traditional feed ingredients, the suppliers of plant and equipment may also have to be found from non-traditional sources such as Brazil, Colombia, Australia, India and Thailand, since these countries have had to develop technologies for similar products.

Potential for Poultry Feed Manufacture

Rationale for Import Substitution

Traditionally poultry have been kept by Caribbean farmers using the extensive system where the *yard fowl* is allowed to run the yard and is occasionally offered scratch grain. Other than scratch grain, the poultry are dependent on the ecosystem for feed. This system allows the birds to find their feed and balance their ration. It may be argued that this system has low productivity, but is also a self-reliant system needing little or no foreign exchange content. This system can still be found among a sizeable group of farmers and households in the Region today.

The adoption of the new methods of intensive poultry production (deep litter, cage etc.) moving away from the traditional, has resulted in the concentration of a lot of birds in poultry housing provided with deep litter or, in the extreme, the battery cage. This has meant, of necessity, that all the feed needs of the birds have to be supplied in the housing. Unfortunately, in the Caribbean this system of feeding tends to rely on processed compound feeds in which over 75 per cent of raw materials is imported. It is important to note that in making the change from traditional poultry production to the intensive systems, the requirements of the birds for protein, energy, vitamins and minerals have not changed. What has occurred is an uncritical decision to supply these nutrients from essentially foreign raw materials without having explored the potential contribution of local raw materials.

This paper is not arguing for the abolition of intensive poultry production. To the contrary it is advocating the adoption of a more efficient system of poultry production from the socio-economic perspectives of the Caribbean.

The nutrition of poultry is well known; and there is no restriction that in the formulation of diets, commodities such as corn and soya must be used. However, vitamins and minerals may continue to be imported because they account for a relatively small proportion of the total feed cost. What is important however, is that feeds are formulated to provide desired levels and profiles of amino acids and energy, in particular, so that meat and/or egg production are at target levels. Consequently, it is technically feasible to displace conventional imported ingredients with indigenous resources.

Indigenous Raw Materials - Cassava as an Energy Source

There is a wide variety of indigenous raw materials that could potentially replace corn in poultry diets. Highlighted however are the possibilities for cassava and/or molasses as energy sources. Cassava, in terms of digestible energy supply, has the greatest potential for carbohydrate production of all crops produced in the tropics (Scott et al, 1976). Generally cassava is the cheapest source of calories (energy) in the tropics, and is the most widely grown tropical root crop. In terms of productivity cassava is reputed to be the most productive farm crop as shown in Table 3 (Coursey & Haynes, 1970) after yam.

It is known that cassava root meal has a higher level of nitrogen free extract (82%) compared to that of corn (72%), but the levels of protein and fat are lower (Olson et al, 1969a). Hutagulung et al (1973), have reported that cassava root meal is low in protein (2.3%), fibre (2.7%), ash (1.6%) and fat (1.2%) but is high in carbohydrate (81.2%). Its mineral content, particularly copper and zinc, is low.

The potential of cassava, therefore, lies in its very high energy value. it is also known that energy is the major nutrient supplied by corn in conventional diets. It is therefore obvious that in terms of energy supply in mixed diets, cassava is better than corn.

There exists a proliferation of reports in the literature of replacement of corn in poultry diets (Enrique & Ross. 1967; Olson et al, 1969b; Chou & Muller, 1971; 1971 reported no significant differences in growth rate, feed consumption, feed per gain ratios and mortality rates for chicks fed 0, 20, 30, 40, 50 and 58% cassava pellets. Hutagalung et al (1973) found similar results to those for Muller and Chu (1971) when broilers diets containing 0, 20 and 40 per cent cassava root meal were fed. Table 4 (Phillips, 1974) shows the composition of some diets where high levels of cassava meal were used. Scott et al (1976) indicated the need to feed supplementary methionine when high levels of cassava meal are included in poultry diets.

Based on the above, it is clear that on technical considerations, cassava root meal can replace corn in poultry diets. Thailand has over the years capitalized on this, and has consequently developed a thriving industry for the export of cassava into the European feed market. The Germans and the Dutch in particular have taken advantage of the potential of cassava and its availability as an effective substitute for corn. Phillips (1974) projected that the EEC would use 9m tonnes of pelleted cassava by 1980.

In the Caribbean Region a similar role potentially exists for cassava in the animal feed sector. Both the agronomy and the processing

TABLE 3: Comparative Energy Producing Ability of Various Crops

Crop	Food Production (Kcal/ha/day)
Yam	266
Cassava	250
Maize	200
Sweet potato	180
Rice	176
Colocasia	146
Sorghum	114
Wheat	110

Source: Coursey & Haynes, 1970.

TABLE 4: Composition of Animal Feeds in Germany

Type of Feed	Ingredients (%)					
	Cereals	Cereal by-products	Oil cake & seed	Animal meal	Cassava	Other
Cow standard	-	13.4	24.7	4.5	43.2	14.0
Beef & calf	-	17.3	36.6	5.0	24.1	16.8
Layer medium	26.4	8.0	11.2	12.0	31.6	10.6
Poultry grower	45.7	8.0	3.1	20.0	20.0	3.0
Broiler	-	3.0	17.0	16.5	56.2	6.9
Broiler finisher	-	6.1	15.1	12.4	60.0	6.1
Pig starter	-	20.0	25.3	6.5	47.3	0.9
Pig 0-30 kg	10.0	10.0	23.3	7.6	40.8	8.0
Pig 30-100 kg	10.0	10.0	21.8	5.8	44.5	7.6
Sow	-	10.0	13.8	10.4	49.6	16.0

Source: Phillips, 1974.

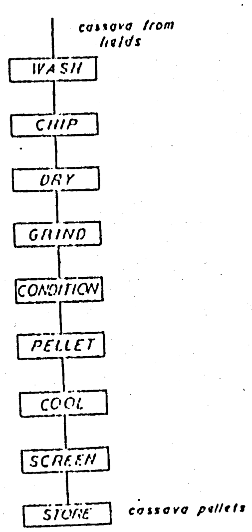
technology are well established and are compatible with the local environment. Realisation of this potential rests upon the implementation of production and processing to meet the Region's needs.

Cassava Processing

In addition to Thailand, both Indonesia and Malaysia export preprocessed cassava to Europe for use in compound feeds. In these countries, dried cassava is exported in a pelleted form in order to increase its bulk density from 420-460 kg/m^3 to 630-700 kg/m^3 when pelleted (Than et al, 1979).

In the production of feed-grade cassava pellets, a number of operations is involved. This sequence is shown in Figure 2. The cassava roots are washed in concrete tanks or rotating mechanical washers to remove clinging mud. Root peeling, while not necessary, is practiced in Indonesia. Slicing and root chipping are accomplished mechanically through indigenous machines. Chip sizes of 1 x 1 x 5 cm are recommended for rapid drying (Best, 1979). For safe

Figure 2: Processing Cassava for Animal Feed



storage, cassava chips must be dried from an initial moisture content of about 65 per cent to below 14 per cent. This is usually accomplished by natural sun drying in the Far East. Drying is carried out principally on concrete drying floors, and a loading rate of 5-7 kg/m^2 is recommended, with drying completed in 1-2 days of good weather. In an industrial cassava processing center, mechanical drying methods using heated air, in continuous and/or batch processes, may be employed. Dried chips are then hammer milled and may be steam conditioned, prior to pelleting. Pellets of 8-10 mm. diameter are usually produced, and are cooled prior to packaging and storage.

In the Caribbean, pelleting of the dried chips may not be economically desirable since the anticipated reduction in transportation cost for moving the pelleted product between the producing centers and the compound feed millers may not offset the additional cost associated with pelleting.

Supply of Protein from Indigenous Materials

This paper has argued for the substitution of imported corn with indigenous cassava for energy. However, it is generally felt that the supply of suitable indigenous protein sources may be more critical. Exploration of various indigenous sources of protein such as copra meal, rendered fish offals, pountry offals, meat meals, leaf protein and distillery sludge (SCP) indicate tremendous potential in satisfying the protein component of compounded feeds. Further, it should be noted that leaf meal and leaf protein concentrate offer tremendous scope for both the replacement of alfalfa now used in formulations, and the substitution of a significant proportion of soya in compound feeds. The technology for rendering offals and for leaf meal production are available, simple and affordable.

Ruminant Feed from Local Feed Resources

Introduction

Ruminants, because of the presence of a fermentation vat (the rumen) in their digestive system, have the ability to utilise certain feed materials which monograstic animals like pigs and poultry cannot, to any appreciable degree. Such feed materials include high cellulosic crop residues and residues from industrial operations. This section of the paper presents examples and the potential for use of locally available crop residues and by-products in the production of complete ruminant diets.

Like all animals the ruminant needs to be provided with adequate:

1. energy
2. protein
3. vitamins and minerals
4. water
5. roughage.

It has been stated previously that the quantities of vitamins and minerals needed in the local compound feeds are so small that they could continue to be imported. The need for water is already being met or could be easily met. The problem therefore reduces to the supply of energy and protein.

Potential Energy Sources

The potential indigenous sources of energy for the production of complete ruminant diets include the following:

1. *Bagasse* - This is a highly cellulosic material produced in quantity in the Region is rarely utilized as a feed source. It provides energy for the ruminant, especially when its digestibility has been enhanced by processing. Additionally, bagasse has very good roughage characteristics.
2. *Rice straw* - This resource is presently produced in quantity in Guyana and to varying degrees in Belize, Trinidad and Jamaica. Like bagasse, it has good roughage characteristics and its feeding value can similarly be enhanced through processing.
3. *Molasses* - This is a highly digestible energy source produced widely in the Region. Unfortunately, its use in animal feeds is principally restricted to feed conditioning and as an appetizer.
4. *Cassava* - The potential of cassava as an energy source has already been discussed previously
5. *Citrus pulp* - It is currently produced in Trinidad, Jamaica and Belize. Most of what is produced is currently utilized in compound feed manufacture. With a well defined system for collection and processing, its availability may be enhanced.
6. *Arrowroot bittie* - This is a by-product of arrowroot starch production and is currently underutilized. The fine bittie has very high energy value while the coarse bittie has both energy value and good roughage characteristics.
7. *Reject bananas* - This commodity is mostly available in the Windward Islands and Jamaica and constitutes a good source of energy, When used without drying and processing it could be a very cheap source of emergy. It is estimated that 25 per cent of the bananas producted is rejected either in the field or at the boxing plant.
8. *Rice bran* - This is available in quantity in Guyana and is currently utilised in compound feeds. Limited quantities are currently available in Belize, Trinidad and Jamaica.

Potential Protein Sources

The supply of protein for ruminants is made a lot easier by virtue of the ability of the ruminant to synthesize microbial protein in its rumen using essential non-protein nitrogen (NPN). Research using dairy cattle has shown that all the protein needs of ruminants can be met from NPN-urea (Vitanen, 1966). However, non-protein nitrogen has traditionally been used to supply up to 30 per cent of the total protein needs of the ruminant. Accordingly, ruminant protein supply could be separated into:

1. NPN; and
2. true protein.

In the Caribbean NPN is available in quantity as Ammonium Sulphate, Ammonia (NH_3) and Urea, all of which are manufactured in Trinidad. Potential sources of true protein in the Region include:

1. rendered fish meal and fish offals
2. poultry by-product meal
3. cotton seed meal
4. copra meal
5. leaf protein e.g. Leucaena and cassava.

It is argued that given these indigenous feed resources, the Region can and should produce ruminant diets relatively cheaply and thus avoid having to rely on expensive and foreign exchange dependent raw materials.

Industrial Processes for the Manufacture of Nutritionally Improved Bagasse/Rice Straw-Based Feeds

The digestibility of bagasse/rice straw for ruminant feeding may be improved principally through chemical or physical processing. Sodium hydroxide or ammonia are the primary alkalis used for chemical processing. The data for previous research (Sankat & Benjamin, 1984) showed the effects of varying levels of NaOH and NH_3 on the *in vitro* dry matter digestibility of rice hulls, bagasse and cane tops (Figures 3 & 4).

Sodium hydroxide is a faster acting and more effective chemical treatment than NH_3. The quick action of sodium hydroxide on lignocellulosic materials such as rice straw and bagasse, may be acceleraged even further through external heating. The heat enhanced action of NaOH has

Figure 3: The Effect of NaOH on the In vitro Dry Matter Digestibility of Residues at 25% Moisture Content and After 24 Hours

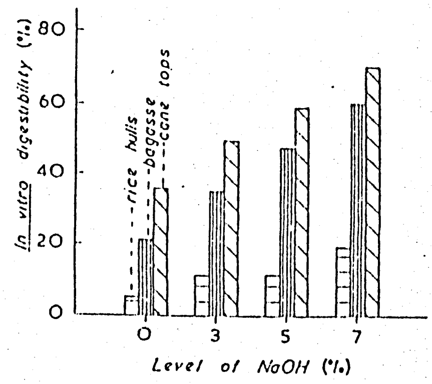
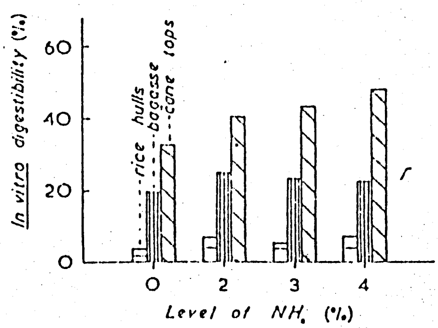


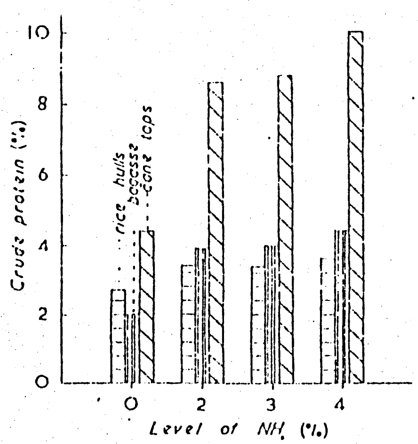
Figure 4: The Effect of NH_3 on the In vitro Dry Matter Digestibility of Residues at 25% Moisture Content and After 7 Days



enabled feed manufacture from straw or bagasse to be commercialized in a continuous, industrial process. The rise in temperature in the final pelleting operation provides the conditions for completing the chemical changes in the straw. In this process, NaOH application is usually 4-5 per cent on a straw dry matter basis.

At present, the ammonia treatment process is amenable to batch processing or on farm processing. From a nutritional viewpoint, the NH_3 process has additional benefits compared to the NaOH process. Ammonia treatment can significantly add NPN to the treated bagasse, as shown in Figure 5. Further, it avoids any possibilities of sodium loading. The manufacture and availability of NH_3 in Trinidad and Tobago, also improves the potential economic benefits of such a process.

Figure 5: The Effect of NH_3 on the Crude Protein Content of Residues at 25% Moisture Content and After 7 Days



Plants for the manufacture of straw or bagasse-based feeds using the NaOH process, are currently manufactured in Europe e.g. Denmark, West Germany, and Switzerland. Bagasse, unlike many other agricultural residues, is available at fixed locations adjacent to the sugar factories, and therefore represents a raw material with considerable potential for commercial feed manufacture, using the NaOH process.

The unit operations, complexity, and initial cost of plant and machinery to manufacture animal feed from bagasse depend principally on plant capacity and the products to be manufactured. In Trinidad and Tobago, with an already established feed manufacturing capability, the following alternatives are available:

1: One option is a plant for the production of a complete, pelleted, ruminant feed and other compound feeds based upon NaOH-treated bagasse or rice straw. In such a plant (Figure 6) three ingredient input lines have to be established for the continuous feed manufacturing process:

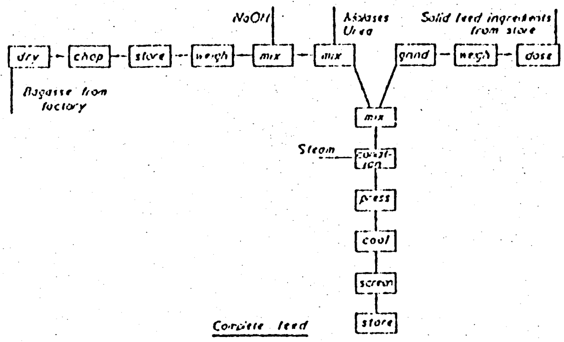


Figure 6: A Process Flow Chart for Processing Bagasse in a Complete Ruminant Diet

(a) a process line for bagasse;
(b) a solids handling and weighing line for such other feed ingredients as rice bran, protein supplements and vitamins and minerals that are needed to produce the complete ruminant diet;
(c) a liquid handling, delivery and metering line for such additives as NaOH, molasses and urea.

2. The second alternative is a plant for the production of a NaOH-treated bagasse pellet only. Such pellets, easily handled, could then be used by existing feed millers as an input into the manufacture of compound, ruminant feeds.

The first alternative is the most complex with a corresponding higher initial capital investment, but producing a complete, packaged feed.

Physical processes available for the enhancement of the nutritive value of high cellulosic residues include the *stake* process, which utilises high temperatures and pressures through steam treatment. Additionally, a simple, physical mixing process utilising high levels of molasses, is available. This enables the proportion of cellulosic residues normally used at low levels, to be increased. Such as process has been commercialized in the Sudan for example, utilising Danish equipment. A typical feed formula used in Sudan is presented in Table 5. This process can be readily adapted to the Caribbean, using locally available cellulosic wastes.

TABLE 5: Composition of "Strawmix" in Sudan

Ingredient	*Percentage*
Groundnut hulls	42
Groundnut stems	25
Molasses	20
Groundnut cake meal	8
NPN-Vitamin-Mineral mix	5

Source: Strawmix, Denmark.

Conclusion

This paper has argued for the increased use of indigenous energy and protein sources in compound feeds in the Caribbean Region.

1. The traditional and adopted systems of animal production were discussed. The need for a new, efficient, indigenous system utilising local feed resources, and appropriate technology identified.
2. The need for the type of system advocated is established by the high demand for animal protein in the Caribbean and the persistent call of the policy-makers to reduce the high animal feed import bill in the Region.
3. As an example, cassava was highlighted as an energy source, but the argument also applies in varying degrees to the use of other indigenous energy sources like molasses and even raw sugar. The question may be asked: Why sell sugar at a loss to buy corn when significant quantities of that sugar could replace corn in animal diets?
4. The potential for using rendered fish meal, fish offals, meat meals, cotton seed meal, copra meal and leaf protein, either as partial or complete replacement for costly imported soya has been highlighted.
5. Viable, commercially available technologies for the processing of agricultural products and by-products such as cassava and bagasse have been identified. These technologies are not far fetched but very much in line with the changing trends in feed manufacturing today.
6. Previous and on-going research in the Region, particularly in Trinidad and Tobago shows that indigenous feed resources can be successfully utilised in the manufacture of compound, animal feeds.
7. Worldwide, in the sixties, oil prices were low. Particularly in Europe this lead to the production and supply of low cost imported feedstuffs, e.g. soya and corn. The drive for greater production at this time, lead to intensive selection of animals to utilise these cheap grains. However, in the seventies, with higher oil prices, and the health problems associated with low roughage rations, the move towards usage of local, high fibre feedstuffs became popular again.
8. In Europe there are commercial processes in operation for making compound feeds using agricultural and industrial residues. In the Caribbean there is even greater need for such technologies, noting our dependence upon imported feeds. The agribusiness potential which such technologies offer, are very attractive.

Considering the above, and being fully aware that the virtue of the ruminant in particular lies in its ability to utilise high fibre materials, developing countries like those in the Caribbean should embark upon programmes aimed at increased use of indigenous feed resources. It is imperative that, use of local products, use of simple processing machinery, minimum use of imported inputs, and the initiation of the policy and institutional arrangements for implementation, be accorded high priority.

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