THE DEVELOPMENT OF INTENSIVE, INTEGRATED AND SUSTAINABLE LIVESTOCK PRODUCTION SYSTEMS:

THE SEARCH OF THE SUGARCANE FEEDS CENTRE

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INTRODUCTION

Development is or should be the goal of all societies. It occurs when there is a change in the status quo with a movement from one level of existence to another characterised by improvements in production and the general standard of living of the population. Many countries of the Northern Hemisphere have been able to make tremendous stride over the years in increasing food production and living standards while in contrast, in the South, agriculture has been unable to keep pace with population growth. In recent times the systems of production used by both Northern and Southern countries are coming under increasing scrutiny; it is now being recognised that many of the methods utilized in agriculture today cannot be sustained. The environment is being polluted, groundwater is being contaminated, once fertile agricultural lands are being converted into deserts and bio-diversity is seriously threatened. The links that traditionally existed between livestock and crop production were weakened or broken in the quest to operate larger and more profitable farming enterprises. Integrated farming, (where a mixture of tree crops and shrubs in combination with livestock which mutually enhanced and balanced each other) gave way to monoculture, the *modern* farming system. Long term viability and sustainability were sacrificed for short term profitability.

Today there is much emphasis being given to the concept of sustainability as man recognises that resources are finite and that his long term future depends on his ability to keep a balance in his environment. But what is *Sustainable Development* and to what extent is it feasible? The 1987 *Bruntland Report* defines sustainable development as; "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*"

The FAO definition states: "*Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment of continued satisfaction of human needs for the present and future generations.*"

It is difficult for an industry such as agriculture to be totally self-sustaining i.e. where input equals output and nothing is lost from the system at the locality of production. It may be more feasible to look at sustainability not only at the farm or national level but in a global context. Such a concept or view would be in keeping with the Biospheric World View recognizing the two basic laws of thermodynamics. The degree to which systems are able to approach this level will determine their long term success and ultimately the success of man's continued colonization of planet earth.

It is the authors' view that there are three aspects of sustainability that must be in place for the long term success of any technology.

(a) Technical sustainability - The technology

must be technically feasible. The physical inputs of production (suitable land, water, fertilizer, seeds, stock etc.) must be available now and continuously into the future. The system must be able to replace inputs which are utilized without a net depletion of stock or a net negative impact on the environment as a result of their application over time.

(b) Financial sustainability - The technology must be financially rewarding to the producer in meeting his needs, and yet must be efficient enough to allow pricing of the product within reach of the consumer.

(c) Socio-cultural sustainability - The technology must fit well with the customs and norms of the society.

THE ROLE OF SUGARCANE IN THE DEVELOPMENT OF CARIBBEAN AGRICULTURE

Sugarcane *(Saccharum officinarum)* has perhaps been the major influence in shaping the Caribbean as we know it today. The crop was imported into the Region, but is well suited to our conditions. It can withstand periods of drought as well as waterlogging. It has the potential of being the highest yielder of biomass on an annual basis. That the crop after planting or cutting covers the ground quickly, harvesting only needs to be done once per year and replanting once every five or more years are important factors in maintaining the integrity of our relatively poor and fragile soils. The industry, however, typifies the commercialization phase of the development of agriculture, showing little linkage with the rest of the economy.

In the pre-independence era, control was not in the hands of Caribbean people, but the post-independence era has brought little change to the sugar industry and Caribbean agriculture in general. Probably the most radical changes have occurred in Cuba where sugarcane is the nucleus of a wide and varied industrial diversity ranging from paper making to medical supplies. In Grenada, sugarcane is now only grown for the direct production of rum and other spirits. In St. Lucia and Antigua, it is no longer cultivated. It is still an important crop in Guyana, Trinidad and Tobago, Barbados, St. Kitts and Jamaica. St. Vincent had been in and out of production several times in the last three decades.

Generally, the main products of the industry are still:

(a) Raw sugar mainly for export.

(b) Molasses for export to be used in livestock feeds or in rum production.

(c) Rum produced locally for export as well as local use.

(d) Bagasse some of which may be burnt to provide energy for the sugar factory, but most of which is generally underutilized.

The industry is still largely oriented to supply primary inputs to external agents with little linkage to local agricultural or agro-industrial development.

THE COUNTRY

Trinidad is the most southerly island in the Caribbean chain, lying just east of Venezuela. Together with Tobago, it forms a twin-island state with an area of 5,128 sq. km and a population of 1.2 million, making it the fourth largest nation in the English-speaking Caribbean. The labour force was estimated to be 463,000 in 1989, with 22 per cent unemployed.

The economy is driven by petroleum. Gross Domestic Product (GDP) per capita was over US$6000 in 1987. This has been reduced to $3000 with the collapse of world oil prices. GDP in 1989 was over TT$15 billion with petroleum accounting for 28 per cent and agriculture, 3 per cent.

Consumption of livestock products is high, but, apart from pigs and poultry, livestock populations are low (Table 1).

The country is self-sufficient in fresh pork and poultry, consumption in 1987 being 3.4 million kg and 25 million kg, respectively. The equivalent of 136 million litres of fresh milk, along with approximately 11 million kg of meat (beef, mutton, chevron and prepared meats) are also consumed, with 15 million litres of milk and 1.4 million kg of meat being produced locally. For the importation of milk and milk products, and meat and meat products, Trinidad and Tobago spent TT$271 million in 1989. Locally, feeding systems are based almost totally on imported ingredients

such as corn, or by-products of locally processed, imported ingredients such as soyabean meal and wheat middlings. With declining terms of trade and structural adjustment programmes being embarked upon, the ability to sustain such a drain on foreign exchange comes into focus. But if it were possible for Trinidad and Tobago to produce the food it requires, the question remains: Can systems of production be developed which will allow us to produce the food we need without compromising the environment, a question not only relevant to Trinidad and Tobago but the wider Caribbean and the world at large.

Table 1. Estimated Livestock Population for Selected Species in Trinidad & Tobago, 1986-87

Dairy Cattle	25,300	Pigs	74,000
Beef Cattle	11,500	Broilers	17.5 mn
Buffalo	4,800	Breeders	270,000
Sheep/Goats	35,500	Layers	375,000

Source: Central Statistics Office, 1987.

THE DEVELOPMENT OF LIVESTOCK FEEDING SYSTEM AT THE SUGARCANE FEEDS CENTRE (SFC)

An inter-relationship has long existed between sugarcane and livestock production in the tropics. Up to the 1950s, animals were used in transport and other operations prior to the use of fossil fuel powered machinery. The animals were fed cane tops and molasses, particularly in the dry season when other forages were in short supply, a practice which still exists among many small sugarcane farmers. It was however, only in the last three decades that interest was focused on the use of whole plant as an animal feed.

The SFC was established in Trinidad in 1976 with Canadian International Development Agency (CIDA) funding to demonstrate the technical and commercial viability of using sugarcane as a feed for livestock, as an alternative to sugar production. Initial work was done with the derinding technology. Sugarfith or comfith, the name given to the material produced after the cane stalk with its top removed was passed through a machine with separated the hard outer rind from the energy rich pith was used as an animal feed. Previous to this, feeding trials using the derinding technology was done in almost all Commonwealth Caribbean territories. In fact it was this derinding machine which initiated the work in the use of the whole plant as an animal feed in Trinidad. The sugarfith was fed with chopped cane tops and a supplement comprised of an imported protein source (soyabean and/or rape seed meal) corn, urea and inorganic mineral and vitamin premix to dairy and beef cattle in zero-grazing conditions.

In Trinidad, the derinding technology was found to be technically feasible but it was soon replaced by the simpler technology of chopping and feeding whole sugarcane with a supplement. The initial cost of the derinder was high, as were maintenance and operating costs. Labour requirements needed for harvesting, preparing and processing the stalk were also high, and there were frequent breakdowns of the equipment. In addition to this, no factory had been established in Trinidad for converting the rind of the sugarcane into particle board. Instead of being an input into a potential lucrative particle board industry, the material had to be dumped, adding to cost of the operation. Animals tended to perform better on derinded sugarcane as compared to chopped whole sugarcane, but the difference was not economically significant in the situation.

Since 1981, the SFC has been a project of the Government of Trinidad and Tobago supported through the Ministry of Agri-culture. A variety of erect grasses and legume trees are grown for feeding the population of beef and dairy cattle, sheep and goats. An abattoir and aquaculture unit were established in 1988.

In 1991, a Technical Cooperation Project (TCP) was signed by the Government of Trinidad and Tobago and the Food and Agriculture Organi-zation (FAO). The TCP is being implemented at the SFC. As a result, additional animal species including ducks, pigs and rabbits have been introduced. This reinforced the central focus of the work at the Centre i.e. the use of sugarcane as a base for the development of viable, intensive, integrated and sustainable livestock production system.

The TCP work is also done on collaborating farms throughout the country.

THE SUGARCANE FEEDS CENTRE INTEGRATED SYSTEM

The SFC operates on 60 ha of relatively flat lands with natural water courses and springs. An expanding village settlement has been established over the years so that production is taking place in close proximity to a village. Villagers are partially dependent on the springs for their water supply. A potential for conflict between the development of the farm and that of the community exists in terms of the potential for pollution of water courses and odour emanating from the livestock operations.

The SFC Philosophy - This concept recognises four basic levels in the production/ consumption environment that needs to be managed.

1. The soil and water
2. The crops
3. The livestock
4. Man.

Level 1 - The Soil and Water:

Soils are made up of mineral and organic matter and water. These constituents largely determine the productivity of the land in terms of what and how well crops can be grown. The soil at the Centre, an acid ultisol, has the following characteristics: low Ph, (3-4), low nutrient status, poor internal drainage, absence of structure, and high aluminium and iron content. It is also weathered. Clay from the top layer has been leached down into the profile creating a hard pan not far below the surface. These features combine to produce a poor soil which rapidly gets bone hard in the dry season, and easily waterlogged in the wet. Two-thirds of the soils in Latin America and the Caribbean are ultisols so there is the need to manage them and make them more productive. The main industry in the area is the making of clay bricks; the natural vegetation is secondary woodland and sedges.

Level 2 - The Crops:

Left undisturbed, most soils develop a cover which may be capable of reducing the rate at which nutrients are lost and some sort of equilibrium is achieved. In this case, the roots of the larger trees reach deep into the soil and recycle nutrients that may otherwise be beyond the reach of other plants. The natural vegetation provides a permanent cover and protects the soil from erosion.

The natural vegetation had to be cleared for sugarcane cultivation, a crop not grown to any extent in the area. This upset the natural balance. Sugarcane is a surface feeder and the leaves and stems were to be harvested and fed to animals in pens. This would represent a tremendous drain of the nutrients of the previously *balanced* ecosystem. Successive harvests of the crop would not have been sustainable. The *modern* solution is the use of high levels of inorganic fertilizers to supply nutrients. The traditional approach is use of animal manure. The indiscriminate use of both have their dangers. Excessive inorganic fertilizer or the liberal use of untreated animal manures can contaminate surface and underground water.

The SFC system involves the collection of wastewater and manure from the animal population in a biogas plant and an effluent pond. The biogas plant produces a combustible gas, methane, which can be used for heating, lighting or generating electricity with appropriate equipment. It also reduces the biological oxygen demand (BOD) of the waste water rendering it safer (environmentally) to be applied onto the field. It also enhances the value of the manure. Any shortfall in nutrient require-ments of the crop can then be supplied through the use of inorganic fertilizers.

Sugarcane as a forage has an advantage not always recognised. It is only harvested once per year and ratoons for four to six years so there is less disturbance to the soil. Fast-growing trees such a *Leucaena leucocephala* and *Acacia mangium* are grown for forage and can be coppiced for many years. These latter crops also have the advantage of drawing on nutrients at a lower level than the sugarcane or other grasses. Studies done with feeding *Leucaena* has been successful particularly with growing stock and dairy animals.

Level 3 - The Livestock:

Ruminants: The harvested sugarcane is chopped and fed to the ruminant animals. These

animals produce meat and milk and as well as manure and inedible products (at slaughter). Meat and milk provide food for Man at the highest level. Inedible offal obtained at slaughter is converted into meat meal and used as an ingredient in other livestock rations, for example, fishfeed. Skins are used to make leather. The manure is washed from the pens and treated in a pond or biogas plant prior to being applied to the fields. The benefits are:

(1) Improved soil structure through organic matter addition.
(2) Addition of major, micro and trace elements to the soil.
(3) Reduction of the odour problem normally associated with livestock production.
(4) Water, necessary for all growth and life, is added at the same time. (Water is important since its shortfall is the major limitation to crop growth in the dry season.)

Aquaculture: Aquaculture is another component in the system. Animal manure is used to fertilize ponds. This stimulates the growth of plankton. Plankton is the natural food for such species as the Tilapia which are grown in the ponds. Supplemental nutrients to boost the growth rates are provided through formulated feeds which may contain slaughterhouse waste. Fish produced is consumed by man at the highest level. Waste fish, e.g. excess female fingerlings, or fish waste is converted to fishmeal and used as a feed ingredient for the other classes of livestock.

Level 4 - Man:

The ultimate aim of the system is to provide food for an increasing human population on a continuous basis and in the right quantity, quality and at a price that is profitable for the producer and affordable for the consumer. However, there still appears to be a missing link i.e. use of waste produced by man? Logically, there should be some mechanism for returning this to the land. This is a problem that cannot be entirely solved on the individual farm and will require a national perspective and changes in attitudes of the population.

THE SUGARCANE VILLAGE

The sugarcane village is the term given to the system now being implemented by the SFC under the sponsorship of the FAO by the consultant Dr. Rena Perez of Cuba. Essentially, it is a deepening of the work of the Centre and involves the on-farm fractionation of sugarcane in a manner that is fundamentally different from the original derinding technology. Firstly, the leaves are separated from the stalks. The stalks are then pressed to expel the juice in a simple three-roll mill. This mill removes approximately half of the weight of the stalks as juice. The juice, which is rich in energy, and low in fibre replaces maize as the energy source in the diet of the monogastric animals, pigs and ducks. Their diet is completed by providing a protein/mineral/vitamin supplement, usually based on soyabean meal or whole boiled soyabeans.

The pressed cane stalks, along with the tops are chopped and fed along with a farm-grown legume tree such as *Gliricidia* or *Leucaena,* a molasses-urea-salt block supplement which acts as a carrier for urea (provides non-protein nitrogen) and an energy supplement).

Work is also on-going to develop feeds for rabbits from B- molasses and refinery *jett,* products of sugar processing. Azolla, an aquatic fern is also being evaluated as a source of feed for cattle, sheep, goats, ducks and fish. It has 30 per cent protein in the dry matter and reportedly has the potential to double its weight every three days.

Sugarcane Village Results

The first two trials are reported on here. The first was a comparison of the use of sugarcane juice and a protein supplement vs the standard corn/soyabean meal system for fattening pigs. Ten weaned piglets were placed into two groups of five; one group was offered a commercially available pig grower *ad libitum.* The other was offered sugarcane juice *ad libitum,* and a supplement designed for feeding fish, containing 35 per cent protein based on soyabean meal and some fish meal. The trial ran for 56 days.

The second trial featured the use of Leucaena and pressed, chopped sugarcane stalks (PCS) with supplementation for growing female goats, female sheep and intact ram sheep. The initial diet consisted of pressed cane stalks and leucaena (80:20 ratio) broiler litter and rice bran (90:10 ratio) and molasses-urea-salt (MUS) blocks available free choice. This ration was later changed to PCS and Leucaena in an almost 1:1 ratio and maize/soyabean meal in a 3:1 ratio.

RESULTS

Table 2 summarises the performances of pigs fed either SCJ or the standard commercial diet. Average daily gains (ADG) dry matter intakes (DMI) and feed conversion efficiency (FCE) were 0.71 and 0.61 kg, 1.64 and 1.72 kg and 2.3 and 2.8 for the SCJ and standard diets, respectively.

Table 2. Observations of Pigs Fed Sugarcane Juice (SCJ) and a Protein Supplement Vs Corn Soyabean Meal Diet (standard diet)

	Prawn Feed +SCJ	Pig Grower Control
No. Animal Feed	5	5
Days Fed	57	57
Liveweight Data (kg):		
Initial Lwt.	17.7	18.9
Final Lwt.	58.0	53.4
Avg. Lwt.	37.9	36.2
Avg. Daily Gain	0.71	0.61
As Fed Intake: Juice	6.8	-
Supplement	0.67	1.97
Dry Matter Feed Intake (kg)		
Total DMI (g/d)	1.64	1.72
DM Supplement (kg/d)	0.69	-
DM SCJ (kg/d)	0.95	-
Feed Conversion Efficiency:		
kg TDMI/kg Gain	2.3	2.8
kg Supplement/kg Gain	1.0	-
kg SCJ/kg Gain	1.3	-

Table 3 shows the labour requirements as measured for activities involved in both feeding systems.

The cost of production is assessed in Table 4 SCJ cost is derived from sugarcane production cost assessed in Appendix 1 and the cost of extracting juice assessed in Appendix 2.

Table 3. Labour Requirements: Time/Pig/Day (hrs.)

	Juice	No Juice
Harvest Cane Stalks (5 hrs/tonne)	0.097	-
Loading Units trailer (3.10 hrs/tonne)	0.049	-
Transport (0.53 hrs/tonne)	0.008	-
Juicing Cane (9.27 hrs/tonne)	0.065	-
Feeding Juice (4.0 hrs/tonne)	0.028	-
Feeding in Supplement (17.017 hrs/ton)	0.011	.014
Clearing Pens	0.014	0.021
TOTAL	0.347	0.035

Table 4. Preliminary Analysis: Cost of Production (TT$)

	Juice	No Juice
Labour Cost/pig	137	16
Feed Cost/pig - Juice	45	-
- Supplement	82	174
Piglet Cost	100	100
Housing	8	10
Transport of Cane	32	-
TOTAL	404	300
Gross Revenue (6.05/kg)	396	396
Net Revenue (6.05/kg)	(8)	96
Cost of Production/kg lwt.	6.73	5.00

Income over feed cost (IOFC) per day is assessed in Table 5. The data indicates an IOFC of $2.42 for the SCJ fed pigs and $1.31 for pigs fed on the standard ration. Feed cost per kg gain is lower for juice fed pigs vs pigs on the standard system, $2.61 vs $3.90. The SCJ system also has the potential for higher throughput by virtue of higher ADG obtained.

Table 6 gives results obtained on feeding the group of male intact rams on the initial as well as the modified diet. The modified diet showed increase feed intake (2.5 kg vs 1.9 kg as fed/head/ day), increased weight gains, (170g vs 36g/head/ day), higher feed costs ($1.16 vs $0.39/head/day) but positive daily income over feed cost ($0.52 vs -$0.04/head/day) and a much reduced days to market projection (118 vs 555 days). The cost of *Leucaena* used in this analysis is detailed in Appendix 4 and the cost of forage processing is detailed in Appendix 3.

Table 5: Income Over Feed Cost/Pig/Day and Feed Cost Per Kg Gain

	Juice			No Juice		
	Qt.	Price (TT$)	Cost	Qt.	Price (TT$)	Cost
Juice Intake (kg)	6.8	0.888	0.598	-	-	-
Supplement Intake (kg)	0.67	l.89	1.27	1.97	1.21	238
Total Costs (TT$)	-	-	1.868	-	-	2.38
ADG (kg)	0.71	6.05	4.29	0.61	6.05	3.69
Income Over Feed Cost	-	-	2.42	-	-	1.31
Days to Market & Feed Cost/kg gain	70&2.61	-	-	82&3.90		
Thruput (days)	5.2			4.5		

Table 6. Intake of Male Sheep Fed PCS and Leucaena Along with Supplement and Cost of Gain Analysis

	Diet 1	Diet 2
PCS (as fed) g	1400	950
Leu	310	810
Broiler Litter	89	-
Rice Bran	9	-
SBM		150
Corn	-	460
Mol Bl.	180	150
	1988	2520
ADG (g)	36	170
Income/day	$0.36	$1.68
Feed cost/day	$0.40	$1.14
Inc. over feed cost	($0.04)	$0.54
Days to Market days	555	118
Market wt (kg)	35	35

DISCUSSION

The results thus far indicate that the sugarcane village system is technically feasible. In the case of growing pigs, sugarcane juice was able to substitute for maize in the diet giving a 16 per cent increase in ADG.

Purchased feed cost per pig fell by approximately 50 per cent and overall feed cost by over 25 per cent compared with the standard system. However, labour requirements increased almost ten-fold. At the cost of labour utilised in this analysis, TT$6.25 per hour, cost of production exceeds market price in the case of the juice fed pigs by $8, but there is a surplus of $96 for pigs on the standard system.

If the analysis is looked at from the point of view of a farmer utilising his own labour, and return to labour is used as the coefficient, then the juice fed pigs come out ahead, with a *return to labour* of $129/pig vs $112/pig for the standard system.

For the intact male sheep fed PCS and Leucaena, along with molasses blocks and a supplement, ADG varied from 36g to 170g, depending on the supplement used. This analysis reveals that although farmers may wish to reduce feed cost to reduce expenditure by feeding high levels of fibre, there is the danger that animal performance may be so affected as to make the gains uneconomic. Animals fed high levels of fibre had feed cost of $0.40/day, but only grew at 36g/day, days to market being 555. Animals fed lower levels of fibre grew at 170g/day but had a feed cost of just over $1.00. Here, however, as opposed to previously, the gain was economic, cost of production being $7.60/kg compared with a sale price of $9.90/kg. Calculated nutrient intake reveals that animal performances were in keeping with their nutritional intake. Work is now in progress to see to what extent the feed cost could be lowered by replacing the maize/soya bean supplement with cheaper local ingredients such as coconut meal, rice bran or citrus pulp.

Whether the technology is acceptable socially, what can be said is that some farmers either have adopted or are willing to try the system. The technology however, may not only be restricted to farmers growing sugarcane and feeding to the animals. Certainly, the purchase of cane grown by other farmers is a feasible option, particularly in situations when enough land is not available at the location where the animals are reared. Based on the date generated, 1 ha sugarcane, along with I ha of Leucaena, can provide the requirements for approximately 60 ewes and their progeny of 180 lambs and 2.5 sows and their progeny of 40 piglets/year.

On the issue of a comparatively high labour requirement of the system, whether this is good or bad is debatable. In situations of high unemployment and low labour cost, a labour-intensive technology may be socially desirable, and particularly where foreign exchange is conserved in the process.

CONCLUSION

In conclusion, the view that environmental degradation is a result of inefficiency and waste is supported. What is called waste can certainly be an input into another production process thus making for overall improvement in efficiency. It must also be remembered that in the so-called free market economy, private farmers are the main producers. Therefore, whatever production systems that may be recommended as environmentally friendly must be financially rewarding and socially acceptable to them.

In addition it is suggested that the major problem with Caribbean agriculture is not land per se, but the productivity of land. Productivity is generally low. When productivity is low, the demand for land is increased. Technology must be looked at in order to properly address this problem.

The Centre will continue the work in order to make the Sugarcane Village System a better integrated, more efficient and viable system of production in our environment. The SFC views the sugarcane plant along with forage legume trees and other renewable feed resources in addition to by-products of agriculture and agro-industry as having an important role in any sustainable system to be developed in the Caribbean for livestock. Integration with different livestock species allows more complete use of the forage material.

In closing, a quote from the Director General of the FAO published in the magazine

FAO in 1990: Towards a Global Vision of Development is deemed suitable.

> "*The challenge facing the international community is to develop and implement a comprehensive programme for sustainable development, one that seeks to contain ecological damage within tolerable limits while meeting the needs of today's population and conserving the resource base for the future.*"

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APPENDIX 1
Estimated Cost of Sugarcane (stalks) Production, Harvesting and Transport

Items	Rates per Ha	Unit Prices	Cost per Ha
Capital			
Labour Equipment:			
Brush cut	2.5 hrs.	$75/hr.	$187
Plough	7.14 hrs.	$15/hr.	$1071
Harrow	5.1 hrs.	$175/hr.	$875
Bank	2.5 hrs.	$70/hr.	$175
Planting			
Cut	8 mt/ha	$25/m.t.	$200
Transport/spot	5 hrs.	$40/hr.	$200
Head/spread/chop	45.6 hrs.	$7/hr.	$319
Covering	99.2 hrs.	$7/hr.	$694
Liming	4.4 hrs.	$40/hr.	$176
Materials			
Limestone	2.0 t.	$200t/ha.	$400
Cane	8 t.	$100/t.	$800
Total			$5096
Cost After Financing (12% at Declining Balance over 5 years)			$6803
Annual Cost			$1360
Recurrent Cost			
Fertilizer:			
Lab/equip.	1.24 hrs.	$40/hr.	$50
Material	1.0 t/ha	$1300	$600
Weed Control			
Chemical	2.0 hrs.	$40	$80
Manual	2.5 hrs.	$75	$187
Weedicides used			$600
Land Rent			$175
Total			$1792
Total Cost After Financing			$2007
Total Production Cost: $2007 + $1360 = $3367			
Cost of Production/tonne: $42			

*Yield - 80 tonnes/ha whole cane.

APPENDIX 2

Cost of Processing - Juicing

Juicer Cost	$8,000
Life	10 yrs.
Rate	200/hr.
Annual Use	400 hrs.
Annual Cost	
Fixed Cost: Purchase Price - Salvage Value = 8000-800	720
Live in yrs.	10
Insurance (3% of purchase price)	240
Housing ($19/sq.' x 20 sq.'/life in yrs (10)	20
Total Fixed Cost	980
Repair and Maintenance - 80% of purchase price/life in yrs.	640
Fuel 0.06 x HP = 0.06 x 5 gals/hr.	
= 1.350 litres/ha @ $2/litre	1080
Oil, Filter, 15% of fuel cost	162
Total Cost/annum	2862
Cost/hr at 400 hrs.	$7.15

APPENDIX 3

Cost of Processing - Chopping

Chopper Cost	$8,000
Life	10 yrs.
Rate	200 kg/hr.
Annual Use	400 hrs
Annual Cost	
Fixed Cost: Purchase Price - Salvage Value	$720
Life in yrs.	
Insurance (3% of PP)	$240
Housing	$20
Total Fixed Cost	980
Repair & Maintenance (80% of PP/life in yrs)	$640
Fuel 0.06 x HP = 0.06 x 8 = 0.48 gals/hr.	
= 2.16 l/hr x $2/l	$1728
Oil, Filter, 15% of fuel cost	$259
Total Cost/Annum	$3,607
Cost/hr.	$9.02
Processing Cost/kg	
Rate = 200 kg/hr - 200 kg/$9	
Cost/kg = 9/200 = $0.045/kg	

APPENDIX 4

Estimated Cost of Production/Harvesting for Leucaena Forage in Trinidad & Tobago

Establishment Cost	TT$*
Land Preparation (brushcut, plough, rotovate and bed formation)	$2000.00
Limestone (2 tonnes per ha)	$1000.00
Labour for application (10 man-days per ha)	$ 500.00
Planting material - 5 kg seeds	$ 400.00
Planting (10 man days/ha)	$ 500.00
Weed control:	
Chemical - pre-emergent: Decthal @ 8 kg/ha	$ 256.00
Labour (5 man days/ha @ $50/manday)	$ 250.00
Pest control:	
Basudin -	$ 200.00
Labour @ 5 man days/ha	$ 250.00
TOTAL	$5356.00
Interest	$3137.00
TOTAL ESTABLISHMENT COST	$8493.00
ANNUAL COST*	$ 849.3
OPERATING COST	
Fertilizer:	
100 kg Sulphate of Ammonia/ha	$ 139.00
100 kg Triple Super Phosphate/ha	$ 137.00
50 kg Muriate of Potash	$ 91.00
Mandays for Application: 60 (6 applications)	$3000.00
Herbicide:	
Roundup - 3 litres/ha x 6 times/yr.	$1425.00
Labour - 5 mandays/ha x 6 times per year	$1500.00
Stumping and Manual Weed Control	$1000.00
Harvesting:	
10 man/days/ha/harvest (with 6 harvests/year)	$3000.00
Interest	$1029.00
TOTAL OPERATING COST	$11321.00
TOTAL ANNUAL COST	($11,321.00+$849.30)
Yield Expected 10 tonnes dry matter (DM)/ha/annum	
Cost/kg DM	$1.22
Cost/kg as Fed	$ .40