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Ruminant feeding from agricultural products and agro-industrial by-products at the Sugarcane Feeds Centre

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The Sugarcane Feeds Centre in Trinidad has shown that, particularly where animal effluent is recycled, whole sugarcane can be used in intensive ruminant production. It is fed, either freshly chopped, or ensiled, at varying levels to animals of different ages and physiological states. It can overcome the seasonal fodder shortage experienced throughout the region. Leucaena is a good protein source to use with sugarcane. Five years ago, the supplements used to nutritionally balance sugarcane diets were imported. These have been almost entirely replaced by local crop residues and by-products, reducing feed costs and increasing local economic linkages without affecting animal performance. New processing plants provide wastes from passion fruit, sorrel, cassava and breadfruit, for use as animal feeds. This benefit from crop diversification is often over-looked. As local production and processing for human consumption increases, so also will the availability of by-products for animal production. (Editor's summary).

Keywords: Animal feeds; Ruminants; Sugarcane; By products; Crop Residues; Leucaena; Diversification

Introduction

The English speaking Caribbean Community is heavily dependent on importation to feed both its human and animal populations. Despite the efforts of many countries of the region to increase food production, the food import bill is close to US $1 billion. Exports from agriculture are only half of this level (Demas, 1987).

The Sugarcane Feeds Centre, a research and development institution, was established in 1976 as a project of the Canadian International Development Agency (CIDA), to demonstrate the technical feasibility and economic viability of the use of sugarcane as a feed for cattle. After five years of operation, it was handed over to the Government of the Republic of Trinidad and Tobago in October 1981. Since that time, the Centre has increased its animal population on a zero grazing system from 500 to over 800. It maintains a calf unit that purchases and rears about 400 animals per year, has a small dairy with 45 head and a small sheep and goat unit of 120-150 head. Male cattle are grown to produce beef and females for replacements, to be sold to the dairy industry. In 1986 over 500 animals and 8000 kg of milk were produced.

The objectives of the Centre for the period 1985 to 1987 are as follows:

(a) To develop sugarcane feeding technology and to facilitate transfer of such technology in Trinidad and Tobago.
(b) To continue to work on protein, energy and other supplementation.

(c) To develop and formulate diets by incorporating local and/or farm grown ingredients to the fullest extent feasible.

(d) To develop feeding and management systems applicable to the Caribbean Region.

(e) To maximise revenue within the framework of the broad objectives.

These objectives confirm a feeding strategy started in 1982 after the Centre had been handed over to local direction and management. The use of whole sugarcane as an animal feed is one aspect of sugarcane diversification. The Centre's programme is a demonstration that further diversification of agriculture is vital to the development of local animal production. Progress can be made in solving the food importation problem if agricultural production and processing are developed and integrated with other activities in the national economy.

The infrastructure at the centre

The Centre is located on 61 hectares of mostly acid ultisol, the Piarco Fine Sandy Loam series. The soil is considered as class IV non-agricultural, and its features include, pH 3.5, - 4.5, lack of structure, low organic matter and nutrient status, high bulk density, small drainable pore space and low water holding capacity (Ahmad and Gumbs, 1978). It becomes puddled in the wet season and rapidly dries out in the dry season. Rainfall is approximately 1800 mm, with a marked dry season between January and May. Pre-implementation studies for establishing the centre revealed a public water supply deficit in the area, so before buildings were completed or lands cultivated, a dam was constructed on an existing ephemeral stream. The lake formed, initially about 3.6 hectares, was fed by rain, run-off and a water bearing gravel layer. This secured water for animal consumption and for pen hygiene (about 50,000 litres per day) and allowed development of large scale irrigation.

The irrigation system consists of a 150 mm PVC underground main with strategically placed risers and hydrants. A traveling sprinkler is used on the sugarcane traces, which are about 70 metres apart. The system is connected into primary and secondary manure ponds. The latter is needed for storage of dilute manure in the wet season. An advancing cavity pump and a diesel powered irrigation pump are used for irrigation purposes in the dry season.

Between 1977 and 1979, about 10,000 metres of sub-surface drainage tubing was installed with laterals at spacings of 10.6, 18.3 and 22.9 metres, depending on the permeability of the location. Planting takes place on ridges one metre apart, to effect surface drainage.

Sub-surface drainage lowers the water table about 30 cm in 24 hours after heavy rainfall, compared with 5 cm in undrained areas. Millable cane stalk was increased by 52 percent by drainage (Cambridge, 1980). Gumbs (1981) reported improvement in the soils after four years of cultivation and application of liquid manure and Livan (1984) reported yield increases through liquid manure application. With limited use of fertilizer (about half the recommended rates), average yields in the order of 60 - 80 tonnes per hectare (stalk and tops) are achieved, and up to five or six ratoons have been obtained.

Sugarcane cultivation is well known so will not be discussed here. The sugarcane variety first used was B41227 and in 1984 a small area of B64134 was planted. Sugarcane as a feed for ruminants is low in protein. To achieve more than maintenance, the chopped sugarcane must be supplemented with protein and starch to form a balanced diet. *Leucaena leucocephala* CF 95 has been grown at the Centre since 1978 for use as a protein source. Average annual total fresh matter yields on two hectares have been estimated at 8 tonnes per hectare from 1984 to 1986. These yields are less than half those projected by Garcia (1987) from work with small plot, short-term trials. The use of rigid cutting regimes at 6 or 8 week intervals is expected to improve both the total yield and the quality of the forage, as judged by animal performance.

Leucaena establishment on acid soils is not well known and experiences with a system of cultivation are outlined. After 24 - 48 hours soaking, seed was formerly planted in styrofoam cups or in peat pellets, with transplanting onto ridges in the field at 6 - 8 weeks. This has been discarded, in favour of direct seeding (after seed soaking) in continuous rows on ridges. Planting is done by hand. Use of pen manure is beneficial and the young seedlings must be sprayed weekly to control mole crickets and leaf eating ants. Direct seeding avoids the set back of transplanting and initial establishment is more rapid.

Weed control is essential, though the Leucaena tends to survive under weed cover. Glyphosate, used at one quarter the recommended rate and with a spray shield, was found suitable, although the legume leaves are very sensitive to the herbicide. Gramoxone can also be used, with hand weeding where necessary.

Hand harvesting with a cutlass starts after about six months of growth. The stumps are generally cut at a height of about 15 cm, but cutting at one metre allows for more efficient weed control.

Animal feeding results

For sugarcane feeding, the inverse relationship between percent sugarcane in the diet DM and animal performance has been described in the Centre's reports. The relationship is in keeping with the established forage (or fibre) to concentrate relationship. Ruminant diets need to be properly balanced for protein, energy, minerals, vitamins and fibre. The Centre has developed feeding strategies based on the physiological ability and condition of the animal, its liveweight, nutrient needs and potential for growth. This aims at optimising, rather than maximising the use of sugarcane in the diet. A young growing animal is fed 10 - 15 percent sugarcane, which increases as the animal matures up to about 50 percent, depending on the other diet ingredients and their nutrient content including the fibre levels.

Leucaena has been in use at the Centre since 1980 and is proving to be of increasing benefit to animal production. The dehydrated forage is used in rations at levels varying from 6 to 20 percent. Fed to lactating cattle, Leucaena has been found capable of replacing from 50 to 100 percent of soyabean meal in the diet, with no deleterious effect on milk yield (J.A. Brown, pers. comm.). Milk yields averaged 10.5 kg per day over 300 days when Leucaena was fed at 12 to 18 percent of the total dietary dry matter. Feeding levels at the centre's dairy are currently about 6 percent, being dependent on the quantity of dehydrated Leucaena forage available.

In calf feeding, after weaning at 35 days, dehydrated, 12 week regrowth of Leucaena produced average daily weight gains of about 0.45 kg. When six week regrowth was used, average daily gains increased by 50 percent. Preliminary results with calves fed from arrival at the centre (7 days of age average) to weaning (at 35 days of age) indicate that early growth rates can be at least doubled with Leucaena feeding.

Garcia (1987), in a growth study using Holstein bulls of 150 to 200 kg liveweight, reported growth rates of over 1.0 kg per day when dehydrated Leucaena forage was included in the diet at about 20 percent of DM. Work at the centre with weaned crossbred male sheep consistently shows growth rates of 0.18 to 0.25 kg per day at this same level of inclusion of dehydrated Leucaena forage (C.H.O. Lallo, pers. comm.).

Much of this can be related to stage of regrowth of the Leucaena. While total crude protein yield increases with a longer interval between cuts, the crude protein percentage falls and the forage becomes more fibrous. The Centre plans to extend cultivation of this crop and the Leucaena cultivars of the OAS Caribbean collection will be evaluated in an attempt to identify higher yielding types for the acid soils at the Centre.

Other crops

Until 1981, dependence was on imported maize, and soyabean and rapeseed meals in the formulation of balanced sugarcane based diets. Since that time, the more common traditional by-products of agro-processing e.g. rice endbits, rice bran, brewers grain (wet and dried), wheat middlings and dried citrus pulp have been used in feed formulations. Poultry rendered meal (combining feathers and entrails from poultry processing) was successfully evaluated as a substitute for soyabean meal as a protein source in all diets except for young calves. Diets and comparative costs are shown in Tables 1 and 2.

The latest phase of the Centre's work is on the use of crop by-products as local agriculture receives new impetus. Thus sweet potatoes and cassava tubers unfit for human use have become available in some quantity. Additionally, cassava skins and rejected tubers have been extensively utilized at 20 - 25 percent of the dietary DM as an energy source for growing animals, while the processing of cassava, breadfruit and similar crops is developing.

Two companies produce a passion fruit cordial and the waste material is collected and used as feed. Waste from sorrel processing is also available in season. Most crops give 30 to 60 percent as by-products, either through inefficient processing or by the nature of the fruit or product itself. Ruminant production systems can be based on this, and the more food locally produced and processed for human consumption, the greater will be the availability of wastes or by-products for animal feeding. Another crop residue of increasing availability is maize stover.

R.A.I. Brathwaite (pers. comm.) stated that, increasingly, farmers are achieving planting densities of up to 45,000 plants per hectare with this crop. Maize in Trinidad and Tobago is hand picked for the fresh market. Ears that are of inadequate size or maturity are left on the green stalk and later ploughed in. The Centre has used its harvesting capability to collect and ensile this product with molasses. The idea is catching on as more crop farmers are offering the product to the Centre. Silage making is not common in Trinidad and Tobago despite the severity of the dry season.

Table 1 Diet formulations on a dry matter basis (%DM) with local and imported ingredients fed to small ruminants (Cost in TT cents/kg DM)

Diet Ingredients	Local Ingredient			Imported (Corn/Soya Based)	
	Lactation/ Creep Feed	Gestation	Growing	Growing	Growing
PRM[1)]	8	7	17	0	0
Rice End Bits	10	0	15	0	0
Molasses	17	10	16	15	0
Leucaena	20	10	0	0	0
Rice Bran	43	13	17	0	0
Citrus Pulp	0	40	17	0	0
Sugarcane	0	18	17	35	35
SBM[2)]	0	0	0	24	0
Corn	0	0	0	24	5
Minerals + Vitamins	2	2	1	2	0
Commercial Concentrate[3)]	0	0	0	0	60
Total	100	100	100	100	100
Cost (TT cents/kg DM[4)]	29	41	42	58	70

1) PRM = poultry rendering meal (2) SBM = Soyabean meal (3) eg. dairy ration or calf starter: 4) In 1987. US$ 1.00 = TT$ 3.60

Table 2 Formulation and Costs of Diets for Lactating Dairy Cows (%DM)

Ingredient	Feed type	
	By-Product	Commercial Feed
Sugarcane	23	20
Molasses	17	20
Wheat Middlings	25	0
Coconut Meal	22	0
Maize/Soyabean /Minerals	13	0
Commercial Feed	0	60
Total	100	100
Cost (TT cents/kg DM[1)]	35	56

1) In 1987 US$ 1.00 = TT$ 3.60

Currently the Centre is test growing maize and forage sorghum in conjunction with the Department of Crop Science, UWI, St. Augustine. Attempting to grow the former has been an instructive experience on the acid soil at the Centre. Eventually it is hoped to produce three crops per year with harvesting before ear maturity as a measure against praedial larceny, and the entire plant will be ensiled.

Conclusions

The Sugarcane Feeds Centre is part of a diversification effort that is necessary in the Caribbean. By it's work, it demonstrates the benefits of crop-animal integration on a farm scale. The use of poor soils becomes possible when resources are properly harnessed for the purpose. Integration of crop-animal agriculture on a wider national scale is appropriate, especially for ruminant production. It is suggested that specialists interested in agricultural development should keep in mind the need to explore the possibilities and potentials that exist. In many territories that depend heavily on imported feeds, adapted crops such as sugarcane and Leucaena could be used instead. Many locally available crop residues and by-products are not fully utilized at present, but have potential for feeding. If this is done, the region could rapidly increase its degree of self-sufficiency. Integrated efforts would see a start to better utilization of such resources.

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