# Cottage sugar industries as alternatives for meeting Nigeria's domestic sugar demands

A.C. Wada, A. Gbabo and A.A. Ndarubu

***Abstract:*** *The sugar industry in Nigeria has failed to meet the domestic sugar consumption demands of the country. The combined production figure of the two major sugar companies at Bacita and Numan stands at less than 1% of the requirement. Inconsistent government policies, uncontrolled sugar imports and the capital-intensive nature of large-scale sugar production could all account for this inadequate production level. The National Cereals Research Institute (NCRI) has developed a 10 tonnes of cane per day (tcd) mini brown sugar plant suitable for cottage level sugar production to complement the large-scale plants' efforts. Outgrower schemes currently operated by the Nigerian Sugar Company, Bacita and the Savannah Sugar Company, Numan are potential sources of the raw materials needed by these cottage industries when established in all the sugar cane-growing communities of Nigeria. Newly opened up farm areas of up to 100,000 ha will also provide canes for the plants. This paper presents some of the problems militating against profitable sugar production by large-scale sugar plants in Nigeria. It also highlights areas of cooperation and support by policy makers and other stakeholders in the sugar industry for increased domestic sugar production. This will facilitate the attainment of domestic sugar self-sufficiency, rural industrialization, social and food security.*

***Keywords****: cottage sugar industries; sugar consumption; sugar pricing; sugar self-sufficiency; rural industrialization; Nigeria*

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Sugar production in Nigeria has remained at the paltry level of 1% of annual domestic requirements for the past five years. Meanwhile, sugar-dependent industries have sprung up in their thousands within the same period. Consequently, there has been mass importation of sugar at huge foreign exchange cost to the nation. Import-dependent economies are a drain on the national economies of importing countries. Wada *et al* (2001) reported that, if well harnessed, cottage sugar industries would be better alternatives for attaining sustainable sugar production in Nigeria. However, this cannot be achieved without the support of a strong government policy that ensures favourable sugar pricing for locally produced sugar. Wealthy Nigerian entrepreneurs and other stakeholders also have roles to play in this rural sugar development strategy.

Sugar production is capital-intensive, and to make profits requires a clear-cut government policy on sugar pricing. This sadly has been absent in Nigeria since the inception of the sugar industry four decades ago. The National Sugar Development Council (NSDC) set up by government in 1993 could act as the instrument for realizing this policy. The NSDC, with a sustained sugar pricing policy designed to bail out the colossal losses of

the large-scale sugar industries, can unload all the sugar produced by these giant plants at a little over production cost. Such arrangements would protect the existing large-scale sugar plants from undue competition with cheap imported sugar.

In regions such as America and Europe, governments have deliberate policies designed to cushion the problems of sugar production (TD, 2001). Countries such as Cuba and Brazil have gone a step further to make sugar cane a national security crop, and virtually every family is involved in sugar cane production. Thus, if there is any impediment to the sale of their sugar cane, there is substantial social unrest. Therefore, to forestall such development, governments have made deliberate policies to inject money into sugar cane production. Whenever there is overproduction of sugar, the surplus is dumped, not only to keep the farmers and industrialists in business (TD, 2001), but also to create employment, which guarantees social security. The youth empowerment scheme of the present government in Nigeria represents an opportunity for the sugar cane and sugar industry within a sound sugar policy.

Sugar production the world over is a private sector business. Even so, governments still provide protection to cane farmers and industries (TD, 2001), as indicated above. In some countries, sugar cane farmers' associations own cane farms from which local cottage sugar industries buy their canes. Such associations do not exist in Nigeria at the present time, but the outgrower schemes operated by the two main sugar companies at Bacita and Numan could serve as the primary source of canes needed for the establishment of cottage sugar industries. Other sources may include the yet-to-be-formed cane farmers' associations and newly opened farms near the cottage industries.

It is clear that the large-scale sugar companies cannot achieve the domestic target for Nigeria, but through research and engineering efforts at the National Cereals Research Institute, a 10 tonnes of cane per day (tcd) brown sugar mini plant has been developed to provide alternative approaches for cottage sugar production. This paper may help in creating awareness among Nigerian entrepreneurs to prompt them to consider the possibility of mass producing this type of plant and establishing it in cane-growing communities across Nigeria. Policy makers such as the NSDC and other relevant government agencies are also being called upon to initiate stringent measures that will discourage sugar imports and encourage production to meet domestic needs and a surplus for export to sister African countries. Currently, even out of the little being produced, some still crosses the borders to countries such as Niger and Cameroon.

## Background information on the large-scale sugar companies

Sugar production by the two existing large-scale companies has oscillated between 0.1 and 10.1% of domestic requirements in the last 10 years (Figure 1). Some of the issues responsible for these dismal production levels were given by Wada *et al* (2001). They include: inadequate supply of sugar cane to the factories; few operating sugar factories; myriads of factory and field production problems; and the activities of Nigerian entrepreneurs who support imports rather than domestic sugar production. In addition, there has not been a strong sugar policy in the country to support and encourage the existing sugar companies to produce and sell at a profit. Their products, therefore, are sold at a price that competes with cheap imported sugar. In fact, sugar produced by these companies is rarely seen outside their gates. A pricing policy to protect and promote these companies' production would be a major step towards attaining self-sufficiency in domestic sugar production in Nigeria. However, not until 1993, when the government set up the NSDC (Busari and Misari, 1996) to assist in increasing domestic sugar production, had any effort been made to help with this.

## The outgrowers' scheme

Cultivation of industrial sugar cane on a large scale is limited to the commercial sugar estates. The two main sugar companies directly cultivate and manage cane fields to produce millable canes for their factories. However, none of the estates has ever produced enough tonnage of millable canes to meet the capacities of the mills. Cane production accounts for over 60% of the total operational cost in sugar production and about 70% of the total labour requirement on the estates. The associated high capital, land and labour requirements and, at times, poor weather, make the productivity of the cane fields highly variable, and recently they have suffered dramatic declines in production. The unfavourable government sugar policy and management schemes, particularly those involving pay, frequently cause labour unrest at critical production points, and the large-scale sugar companies have continued to record yield declines that are now reducing to zero.

In order to save some costs, particularly on labour and machinery, the sugar companies initiated cane outgrowers' schemes on the estates to supplement the supply of millable canes, especially from the rainfed uplands. This supply accounts for about 25% of the total annual cane production on the estates. In the scheme, the company provides credit facilities to a list of registered farmers for land preparation, planting materials and fertilizers. The farmers manage the fields under cultivation. The value of the credit advanced to each farmer is deducted from the value of his/her harvest and the net value paid to him/her in cash. Some of the obvious advantages of the scheme include low capital requirement, low labour input, simple technology and efficient overall management of the land. The scheme holds great potential in providing the raw material base for the projected cottage sugar industries in the country.

Active participation of farmers in an organized cane outgrowers' scheme will restore their right to land ownership, which is a contentious issue on the estates. The scheme will enhance quick and widespread cane cultivation with minimal constraints, and will also increase the resource base and diversification of cropping systems. Technologies relating to sugar cane farming systems are currently being developed at the National Cereals Research Institute (NCRI) in respect of weed management, nutrition, protection and intercropping

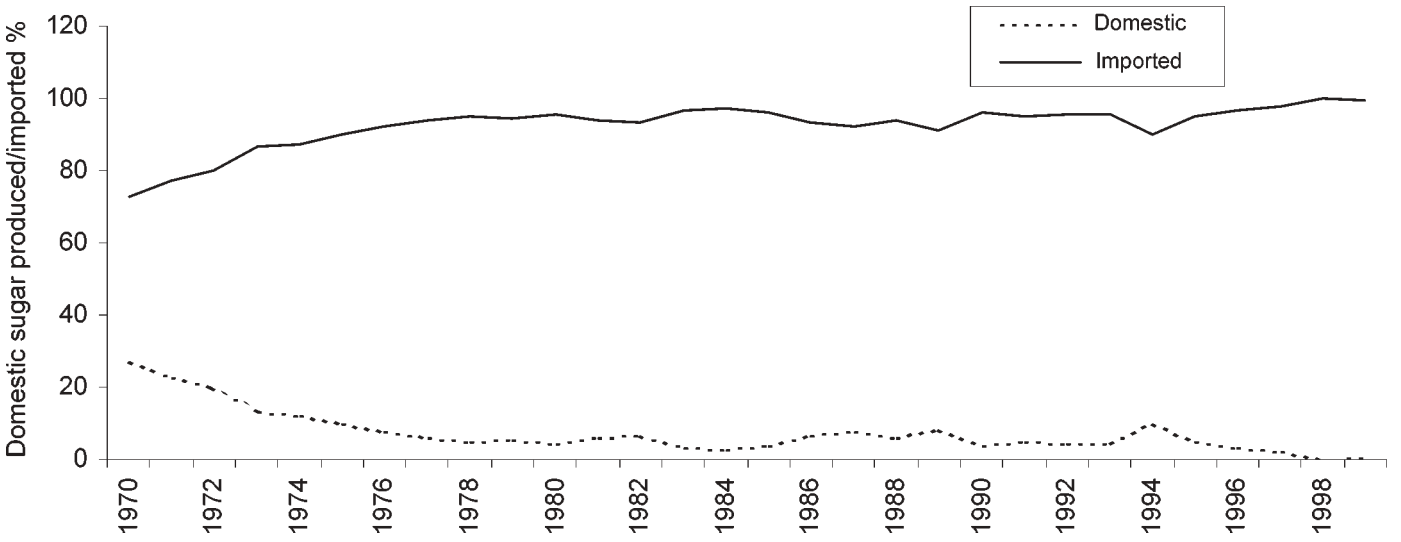


**Figure 1.** Percentage of domestic sugar produced and imported by Nigeria, 1970–99.
*Sources*: CBN, 1997; Nigerian Sugar Company Ltd(NISUCO), 1965–99; SSC, 1983–99.

systems (Gana and Busari, 1999; Ndarubu *et al*, 2000; Ndarubu and Kolo, 2002). Multiplication of the cottage mills in cane-growing communities will also create market outlets for the produce and facilitate the integration of the crop–livestock sector by utilizing sugar by-products such as bagasse and molasses as livestock feeds. Government can support the scheme through the granting of credit facilities to farmers from the National Agricultural and Rural Development Bank (NARDB) and the People's Bank. In this way, the production of sugar will be increased by both the large-scale and cottage industries, thus ensuring emancipation from rural poverty, and food security. The feasibility of this proposal will become even more obvious below.

## Expected role of NSDC in domestic sugar development

NSDC is a specialized parastatal branch of the Federal Ministry of Industry established by Decree 88 of 1993 to catalyse the development of the nation's sugar subsector. This is to be achieved through the formulation of effective policy programmes on the development of sugar estates and the organization of sugar cane outgrowers' schemes, as well as cooperatives to enhance local sugar production for the insurance of national self-sufficiency in sugar. A key role of the NSDC is to reduce the nation's dependence on imported sugar (Busari and Misari, 1996). The Council earmarked some of the following strategies for achieving its objectives:

- rehabilitation and expansion of the existing sugar plants at Bacita and Numan;
- promotion of private development of medium-sized and mini sugar plants at already identified sites and in cane-growing communities;
- encouragement of the development of outgrowers' schemes for industrial cane in villages around existing and potential sugar estates, as well as among chewing cane farmers for the supply of raw materials needed to establish factories; and
- encouragement of research into the development of new sugar cane varieties as well as appropriate cane processing technologies for wide adoption by growers and processors.

NSDC has, since its inception, according to Busari and Misari (1996), striven to achieve the following as its core activities among its large- and small-scale sugar cane growers and investors in the sugar industry:

- farm insurance with the Nigerian Agricultural Insurance Company;
- marketing and price support mechanisms to cane and sugar producers;
- infrastructural development of sugar estates and/or sugar-producing areas;
- guaranteeing credit facilities for all cane farm operations and inputs;
- assistance in skills development in sugar cane production and processing; and
- provision of soft loans for capital projects of existing sugar estates, among others.

## NSDC's activities in relation to its stated objectives

A closer look at the performance of the sugar industry in the past few years, particularly of the NISUCO and Savannah Sugar Companies, reveals that NSDC has not achieved any significant progress in any of its mandated targets. Up to now, the Council has not produced a fair sugar pricing policy to help in reducing imports. Moreover, it has become a big procurer of fertilizer and pesticides for the sugar companies, even though, at least for the Savannah Sugar Company, there has been no crushable crop in the ground to be kept weed-free and/or fertilized. Technology development support by the

Council is almost nil. The Council has also substantially increased technology imports, again departing from its clearly defined mission statement for a sugar production revolution to eliminate the present huge foreign exchange being expended on sugar imports (FOS, 1995–97) and technology. The Nigerian sugar industry needs a strong government policy from NSDC to protect it from cheap and non-nutritive imported sugar. When that policy is adopted, other ways of boosting local sugar production will be through the setting up of cottage mini sugar plants in all cane-growing communities in Nigeria.

The following section seeks to demonstrate the existence of such a cottage sugar industry in the country and the need to support and improve its efficiency as well as mass production for use by small- to medium-scale cane farmers in Nigeria.

## Research to increase production in rural sugar cane communities

The development of sugar processing technology at intermediate or rural levels with indigenous technology has reached a tertiary stage in several other Third World countries such as India, Cuba, Brazil and Puerto Rico (Raphael, 1984). In these countries, enormous socioeconomic benefits have been reaped, thus justifying their existence and improvement (Baron, 1975; Guerrin *et al*, 1977; Garg, 1979; TD, 2001).

In Nigeria, a study of the traditional method for producing a sugar product called *Masarkwoilla* among farmers in some northern states of Nigeria prompted research into sugar processing technology (NCRI, 1986). This was after tests conducted at NCRI had shown that *Masarkwoilla*, being a conglomerate of sugar crystals and molasses produced under unhygienic conditions, had a low acceptability rating (NCRI, 1989). In order to upgrade the quality standard of *Masarkwoilla* produced by small-scale rural farmers and to augment production by the few existing giant sugar companies, a task force was set up by the Federal Government of Nigeria to design, fabricate and commission a prototype brown sugar processing plant using adapted technology. The National Cereals Research Institute was given the national mandate to coordinate and ensure the setting up of the plant at its headquarters in Badeggi in 1987. Accordingly, a 2 tonnes of cane per day (tcd) cane-crushing capacity prototype brown sugar plant was developed and commissioned at the Institute in 1988. Thereafter, several studies aimed at improving the efficiency and capacity of the technology have resulted in the development of a 10 tcd mini brown sugar plant, a unit of which has been established at Sara, near Dutse in Jigawa state since 1999. It is this technology that would benefit substantially from support for mass production by wealthy entrepreneurs and other stakeholders in the sugar industry to site a plant in every cane-growing community in Nigeria for the attainment of sugar self-sufficiency.

## Production process

Cane processing in the mini plant follows a series of steps, as outlined in Figure 2. Cane stalks tied in bundles are first weighed using a hanging balance and the weights

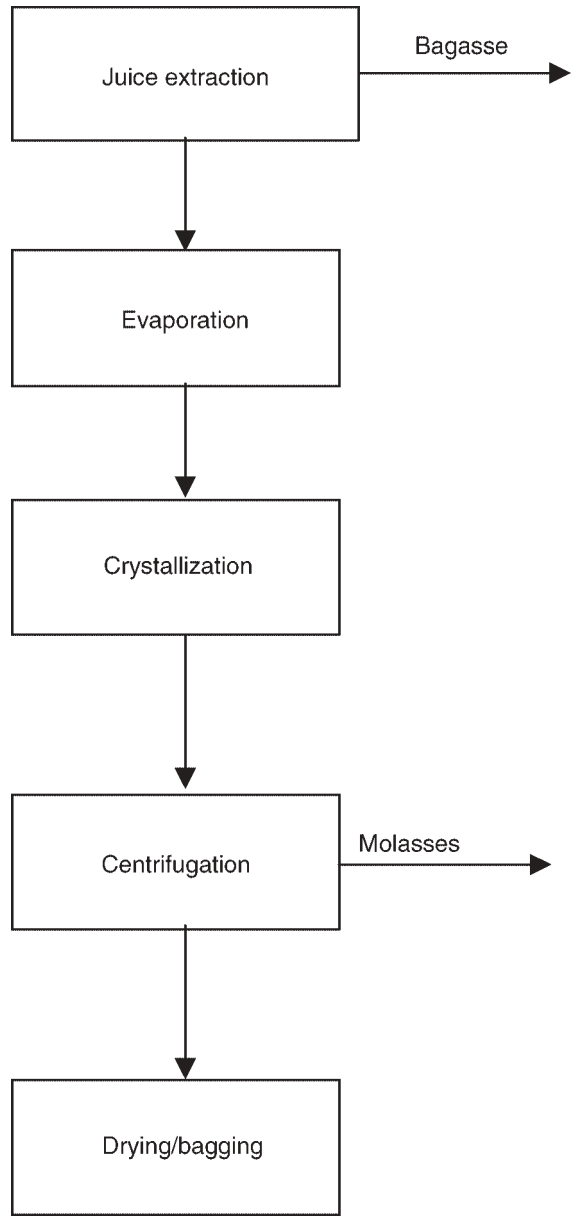


**Figure 2.** Brown sugar processing at the National Cereals Research Institute.

recorded. Three to four cane stalks at a time are then fed into the mills, each of which has a milling capacity of 5 tcd. The stalks that are fed into the mills are delivered as bagasse to an area where they are later collected, spread out to dry and used as fuel for the open pan evaporation system. The extracted juice is collected in a tray, runs through a muslin cloth screen and into the pipes, through which it is conveyed to the boiler pans.

The extracted juice is evaporated in two sets of open pans. Each of these sets is composed of three boiler pans that are filled in sequence. Each pan takes about 400 litres of juice, but the first pan, which is directly over the fire, is only half-filled in order to prevent loss of juice through frothing over. While boiling, okra stem extract is added to the juice, and the scum floating on the surface is removed periodically to yield a clear juice. When the contents of

**Table 1.** Summary of expected output from brown sugar project in 25 states of Nigeria.

| Unit | Annual output per state | Total |
|---|---|---|
| A. Sugar cane (tonnes) | 105,000 | 2,625,000 |
| B. Sugar (tonnes) | 7,350 | 183,750 |
| C. Gross returns on output (₦): | | |
| Sugar cane at ₦1,700/tonne | 178,500,000 | ₦4.56 billion |
| Sugar at ₦42,000/tonne | 308,700,000 | ₦7.7 billion |
| D. Employment generation: | | |
| Factory manager | 280 | 7,000 |
| Factory supervisor | 560 | 14,000 |
| Sales/account clerk | 280 | 7,000 |
| Messenger/cleaner | 280 | 7,000 |
| Unskilled workers | 4,200 | 105,000 |
| Farmers | 2,000 | 50,000 |

*Source*: Anon, 2000b.

the first pan are boiled down and removed, those of the second (middle) pan are transferred into it, and those of the third pan transferred into the second pan, while the third pan is filled with fresh juice, and so on.

The concentrated juice or syrup is removed manually using large-handled spoons once the content reaches 80°. These are first discharged into large plastic drums before being transferred into the crystallizer. The concentrated juice is crystallized in a double-compartment metal tank with baffles and heat exchanging rotary pipes through which cooling water is circulated.

When crystallization is completed, the resulting *massecuite* is discharged into buckets and fed into the centrifuge, which separates the sugar from the *molasses.* The inner basket is washed with a water jet so as to clear the sieves of the centrifuge. The molasses is discharged through vents in the outer jacket of the centrifuge into buckets, while sugar crystals are collected in the inner jacket for drying and bagging.

## Theoretical framework for establishment of cottage sugar industries

As highlighted above, a mini brown sugar plant has been developed by NCRI and is ready for mass production and adoption by entrepreneurs, cane growers and processors. We now develop a theoretical framework to show the expected benefits that would accrue in terms of sugar, rural industrialization and rural employment and to the national economy from establishing these mini sugar plants in the rural areas.

A theoretical analysis targeting the production of 500,000 tonnes of sugar annually from 7,000 units of 10 tcd mini brown sugar plants in 25 states was produced by Wada *et al* (2001). It is reproduced for clarity in Table 1. In order to produce 500,000 tonnes of sugar annually to meet domestic demands, seven million tonnes of sugar cane are needed, assuming a cottage industry average of 7% brown sugar recovery from sugar cane (Anon, 2000a). Projecting an average yield of 70 tonnes per hectare, 100,000 ha are required to attain this level of sugar cane production. That is to say, total industrial cane hectarage in the country needs to be increased by about 90,000 ha with the estates' expected total cane production of around 10,000 ha. Taking into account that the seed rate for industrial cane is 7 tonnes $ha^{-1}$, about 630,000 tonnes of seed cane are needed. It is also assumed that after the current expansion programme of the sugar estates, 50,000 tonnes of sugar will be produced annually. In order to produce another 500,000 tonnes of sugar to reduce drastically the 700,000 tonne shortfall and at the same time to generate rural employment, 7,000 units of the mini brown sugar plant are needed, each providing 70 tonnes of sugar annually (giving a total of 490,000 tonnes). It is known that at least 25 states in Nigeria can effectively devote 3,000–4,000 ha of land to cane cultivation to produce seven million tonnes of cane. Thus 280 units of the mini brown sugar plant can be set up in the cane-growing areas of each state (Anon, 2000a).

## Economic benefits of the strategy, and multiplier effects

### *Employment for local farmers*

The Nigerian government has set itself targets to eradicate rural poverty and empower the nation's youth. The sugar industry is at present the largest employer of labour in the country, with a staff of between 60,000 and 1,000,000 (TD, 2001). The establishment of 280 units of the mini brown sugar plants in at least 25 states will provide employment for an additional 50,000 farmers involved in cane cultivation alone. This is because the cultivation of 4,000 ha of cane per participating state will require at least 2,000 farmers, each cropping two hectares of land (Anon, 2000b). However, if 100,000 ha of land are to be cleared across the country, about 50,000 cane farmers will be required to participate in its cultivation. Assuming that each farm family has six dependants, then over 600,000 people will be affected positively when the economies of these 50,000 farm families are improved.

### *Employment for skilled and unskilled workers*

Employing a factory manager (FM), two factory supervisors (FS), an accountant, four clerks, five skilled factory artisans, 15 labourers and a messenger/cleaner, each mini brown sugar plant will engage at least 25 staff. Achieving the proposed target of 7,000 units of the plant nationwide, over 190,000 jobs of different types will be generated from the cottage brown sugar project (Table 1).

### *Benefit to local suppliers and haulage firms*

Under the input supply scheme, suppliers would benefit from a requirement for irrigation pumps and the sinking of boreholes and wells. The same will go for fertilizer, pesticide and fuel suppliers. General businesses, including transport firms, will thus be available to different users (Anon, 2000b). This development will certainly have a positive impact on the nation's economy. The economies and rural industrialization in other African countries, such as South Africa and Kenya, were rapidly improved by engaging in cheap and affordable cottage sugar production (Amosun *et al*, 2000).

### *Benefit to local fabricators and building contractors*

Establishing 7,000 units of the brown sugar plant in 25

states will require several micro-credit facilities to be available to assist artisans and contractors to participate fully in the sugar business. Thus welders and local fabricators will reap microeconomic benefit from the fabrication of machine components such as cane crushers and crystallizers among other equipment for the plants. On the other hand, civil engineering firms and workers will benefit from the construction of the factory buildings and the sheds housing the mills and boilers. Generation of employment and wages of different categories of Nigerians will thus be enhanced. The per capita income of such individuals will be raised, and this will in turn generate the economic growth of the rural areas where the plants are sited. A positive economic effect will then be felt by the nation generally.

*Benefit to sugar merchants and end-users*

The establishment of the 7,000 units of cottage mini brown sugar plants across the country will boost local sugar production by 490,000 tonnes. This output will no doubt provide business for local sugar merchants as well as local industries, particularly breweries, pharmaceutical, confectionery, soft drinks bottling and beverage and yeast industries. Other industries involving, for example, paper, cardboard and shoes will also spring up near such cottage sugar industries. Above all, this will halt the present drain on the foreign reserve of the nation that goes on unabated through unrestricted cheap sugar imports.

## Dangers inherent in continued sugar imports

As indicated in a preceding section of this paper, the governments of developed countries in America and Europe have formulated deliberate policies on sugar cane, making it a security crop (TD, 2001). It is this sort of policy that has led to the surplus of sugar available for export to Nigeria and elsewhere. Reliance on such imports constitutes a great security risk. The Managing Director of the Nigerian Sugar Company Limited, Bacita, recently asked, for example, should the UK, a major exporter of sugar to Nigeria, cease to export to Nigeria, what then would follow (TD, 2001)?

The sugar cane and sugar industries are also known to constitute the largest employer in Nigeria (TD, 2001). Of late, there have been several social crises across the country, the active participants being unemployed youths. This is said to be because the government has failed to develop the sugar cane and sugar industry satisfactorily to absorb the youths and keep them busy either on the cane farms or in the sugar factories.

## Proposed privatization of the existing sugar companies

Faced with difficulties in sustaining the sugar industry, the government has recently instructed the two large-scale sugar companies to prepare for privatization. However, this may constitute a deadly blow to the already strangled sugar industry. Privatization may be the right step for the sugar industry, but the present environment is not suitable for it. If the desire to privatize is to increase domestic sugar production and stop imports, government should bring these companies and the price of sugar to a level that will attract private investors. Now that the cost of production of sugar far outstrips the selling price, there is no incentive for buyers to come forward, except to asset strip. On the other hand, the sugar industry has employed over four million Nigerians since its inception in 1964 (TD, 2001) and has thus been a strategic part of the nation's economy. The sugar industry should be revitalized and protected by a concrete pricing policy before being privatized.

## The way forward

It is clear that the following steps need to be taken urgently if the industry is to be saved from extinction:

- Government should formulate a deliberate sugar pricing policy to discourage imports. As earlier observed by Wada *et al* (2001) and the MD of NISUCO, Bacita (TD, 2001), the current 5% levy on imported sugar should be increased to 10% or more.
- Foreign exchange saved from sugar tariffs should be used to buy all sugar produced by both the existing large-scale sugar companies and the cottage plants yet to be established nationwide at prevailing market prices. Such sugar should be distributed to government establishments (TD, 2001) and the balance injected into other sectors of the economy to help with poverty eradication.
- An appropriate and supported sugar price will be the only guarantee to local and foreign investors in the country's sugar industry. This is because investors will not want to invest in a commodity whose cost of production far outstrips the selling price, as is currently the case for sugar in Nigeria (TD, 2001).
- Government should ensure that the NSDC meets its stated goals of achieving increased local sugar production. The Council should support technology development and adoption, but not expensive technology importation as it is now doing (Wada *et al*, 2001).
- Patronage from government such as that enjoyed by Peugeot Automobile of Nigeria (with significantly fewer employees than the sugar industry) (TD, 2001) should be speedily extended to the sugar industry in order to save it from its present state of total collapse. This will greatly assist government in its youth empowerment and poverty eradication schemes, whilst at the same time ensuring sugar self-sufficiency and food security.
- Attainment of self-sufficiency in domestic sugar production and rural industrialization in other Third World countries, eg Brazil, India, Cuba, Puerto Rico and South Africa, was made possible through the establishment of rural cottage industries (Raphael, 1984). An aid to this would be for the government and the private sector to collaborate in the mass production and establishment of the 10 tcd brown sugar plant developed by NCRI in several cane-growing communities of Nigeria.
- Farmers' and sugar cane technologists' associations should be encouraged and sponsored by all stakeholders in the sugar industry in Nigeria, as they are in many cane-producing countries of the world.

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## References

Amosun, A., Gbabo, A., and Wada, A. C. (2000), 'Open pan sugar processing technology: an option for developing countries', *Sugar Tech*, Vol 2, Nos 1&2, pp 19–22.

Anonymous (2000a), *Sugarcane Research Programme Report for 1999*, National Cereals Research Institute, Badeggi, pp 53–80.

Anonymous (2000b), 'Sugarcane and sugar production for employment generation', proposal prepared by the Sugarcane Research Programme, National Cereals Research Institute, Badeggi, and submitted to NSDC, Abuja.

Anonymous (2001), *Sugarcane Research Programme Report for 2000*, National Cereals Research Institute, Badeggi, pp 1–6.

Baron, C. Y. (1975), 'Sugar processing techniques in India', in Bhalla, A. S., ed, *Technology and Employment in Industry*, ILO, Geneva.

Busari, L. D., and Misari, S. M. (1996), *Sugarcane and Sugar Experts Directory*.

CBN (1997), *Central Bank of Nigeria Annual Report and Statement of Account, ended 31 December 1997*, CBN, Nigeria.

FOS (1995–97), *Foreign Trade Statistics, 1995–1997*, Federal Office of Statistics, Abuja.

Gana, A. K., and Busari, L.D. (1999), 'Yield and returns of sugarcane (*Saccharum officinarum*) inter cropping with horticultural crops', *Agricultural Tropica Et SubTropica* (Universitas Agriculturut Praga), Vol 32, pp 59–64.

Garg, M. K. (1979), *Project Report and Feasibility Study of Appropriate Technology and Mini Sugar (ADP Khandsari)*, Appropriate Technology Development Association, Lucknow.

Guerrin, B., Armaingaud, J., and Michailof, S. (1977), *"Appropriate Technology" A Survey of the Indian Khandsari Sugar Manufacturing Industry*, Direction Générale à la Recherche Scientifique et Technique, Paris.

NCRI (1986), *Survey Report on Study of Traditional Processing Methods in Northern Nigeria*, Agricultural Extension Research and Liaison Division, National Cereals Research Institute, Badeggi, pp 4–6.

NCRI (1989), *Annual Research Review Meeting*, Sugarcane Research Programme, National Cereals Research Institute, Badeggi, pp 21–24.

Ndarubu, A. A., Busari, L. D., and Misari, S. M. (2000), 'Weed management in sugarcane inter cropped with arable crops in Nigeria', *Sugar Tech*, Vol 2, No 3, pp 34–41.

Ndarubu, A. A., and Kolo, I. N. (2002), 'Sugarcane – soyabean: win or lose', *Coraf Action*, No 22, pp 10–11.

Raphael, K. (1984), *Sugar Processing: The Development of a Third World Technology*, Institute of Development Studies, University of Sussex, Brighton, and Intermediate Technology Publications, London.

SSC (1983–99), *Annual Production Statistics, 1983–1999*, Savannah Sugar Company Limited, Numan.

TD (2001), 'Government is killing the sugar industry' (The Monday Interview), *This Day Newspaper*, Vol 2374, 22 October, pp 45–47.

Wada, A. C., Gbabo A., Ishaq, M. N., and Busari, L. D. (2001), 'Current status of sugar research and development in Nigeria', *Sugar Tech*, Vol 3, Nos 1/2.