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## **Sugar Cane and Sugar Research at National Cereals Research Institute, Badeggi, Nigeria: Time for Collaboration with Egypt's Sugar Groups**

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### **Abstract**

National Cereals Research Institute situated on Lat 09045' N, Long 6007'E at an Altitude of 70.57m above sea level has the national mandate for genetic improvement of sugar cane and five other crops. Thus, National Cereals Research Institute, Badeggi has been involved in Research and Development (R & D) of sugar cane for the past 3 and 4 decades respectively. During this period, seven indigenously bred varieties have been released for use by the Nigerian sugar industries. The research efforts on sugar have also witnessed the development of 10 tons per day (10tcd) brown sugar processing technology for cottage level sugar production. In striving to achieve these novel technologies, various stakeholders were collaborated with spanning from the Federal Government, Agencies of Governments at the Federal, state and local levels and the universities with little or no input from the Nigerian Sugar Industry. Due to some encountered deficiency in key areas for sugar cane and sugar research and production, the Institute finds imperative to seek worthy collaborators in Egypt's sugar groups in biotechnology and sugar technologies for the development of suitable varieties for sugar and ethanol production and the time for this synergy is now. This paper highlights what NCRI has been able to archive in the past decades on sugarcane and sugar research and areas needing urgent collaboration with relevant Egypt technocrat in sugar cane and sugar.

***Keywords: Sugar cane and sugar R &D, Indigenously bred cane varieties, Collaborative efforts, Nigeria.***

### **Introduction**

The National Cereals Research Institute, Badeggi, Nigeria started as a botanical garden of the old colonial administration in 1899 in Lagos. It later became the Federal Department of Agricultural Research (FDAR) and

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established at Moor Plantation, Ibadan in 1954. In 1984, its Headquarters was moved from Ibadan to Badeggi, which hitherto was an outstation for sole rice research.

An Agric Act of 1987 reorganized the mandates of the Agricultural Research Institutes leaving NCRI with its current mandate crops namely Sugar Cane, Rice, Soyabean, Sesame, Ache and castor. The Institute was also saddled with the responsibility of the overall mandate for the Farming Systems Research and Extension for the Middle Belt Zone of Nigeria comprising Benue, Nasarawa, Niger, Kwara, Kogi, Plateau and Taraba states as well as the Federal Capital Territory, (FCT), Abuja.

Charged with the mandate to develop new and improved sugar cane varieties as well as its husbandry techniques, the Institute through the Sugar Cane Research Programme has strived to live to its bidding using conventional breeding techniques. Recently, the protocol for tissue culture and rapid multiplication of seed cane has been perfected with some collaborative works achieved.

Thus, in the area of Sugar cane and sugar research, the Institute has worked over the years with Sugar companies, State Governments, 8 Agricultural Development Programmes (ADPs), National Office of Technology Acquisition and Promotion (NOTAP), Renewable Energy Division of the Nigerian National Petroleum Corporation (RED(NNPC)), Universities and Private Organizations/and some relevant companies in Nigeria mostly. The time has come now for the institute to seek collaboration and extensive networking in sugar cane biotechnology especially in genotypic mapping, sequencing and tissue culture with the view to shortening the period for developing new varieties. The impetus

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for aggressive collaboration has been awakened with my invitation to this international conference on sugar and integrated industries where concrete steps are to be taken with renowned institutions in the area of sugar cane biotechnology and sugar technologists of Egypt.

My talk will center mainly on areas of capacity building, partnership, and strong collaboration with the Egypt's sugar cane and sugar groups especially in sugar cane biotechnology and genomic sequences to cope with biotic stresses especially whip smut declining sugar cane productivity at present in Nigeria (*Wada 1997*).

**Progress made by national cereals research institute in the development of cane varieties.**

The Institute's key achievements with some measurable impacts on Sugar cane and Sugar Research have been:

- The release of 7 varieties of sugar cane from 1998 – 2008 namely NCS – 001, NCS – 002, NCS – 003, NCS – 005, NCS – 006, NCS – 007 and NCS – 008
- Production of Advisory Leaflets on sugar cane production techniques, production manuals of sugar cane production, brown sugar/Alewa processing and directory on sugar cane/sugar experts in Nigeria. Sugar cane scientists/technologists have published technical papers in national and International journals on all aspects of sugar cane research.
- Development of cottage level brown sugar processing plant ((10TCD) and upgraded it to expeller status in 2007.

- Identification of okra-bark as clarification agent as against chemical additives for brown sugar production.

Preliminary breeding work which included introduction of exotic sugarcane clones from sister stations with similar climatic requirement like India, Florida, Brazil, and Australia and the collection of adapted clones from various ecological zones in the country started at NCRI in 1978. These breeding efforts have led to the development and release of 7 sugarcane varieties. Varieties of sugar cane released in Nigeria are designated as NCS series, meaning: National Cereals Sugar cane. So far, seven varieties of sugar cane have been formally registered and released. Table 1 shows some characteristics of the indigenously bred cane varieties by NCRI.

**Table 1. Agronomic yield characteristics of sugarcane varieties developed by  
National Cereals Research Institute, Nigeria**

	<b>Stalk length (m)</b>	<b>Stalk girth (cm)</b>	<b>Stalk weight (kg)</b>	<b>No. of stalks per stool</b>	<b>No. of mill stalks /plot</b>	<b>Cane yield t/ha</b>	<b>Sugar tc/ts</b>
<b>NCS-001</b>	<b>3.00</b>	<b>3.0</b>	<b>0.96</b>	<b>7</b>	<b>203.0</b>	<b>104</b>	<b>10.1</b>
<b>NCS-002</b>	<b>2.75</b>	<b>2.8</b>	<b>0.74</b>	<b>7</b>	<b>186</b>	<b>97</b>	<b>11.2</b>
<b>NCS-003</b>	<b>2.76</b>	<b>2.50</b>	<b>1.17</b>	<b>9</b>	<b>240.7</b>	<b>90</b>	<b>12.5</b>
<b>NCS-005</b>	<b>2.70</b>	<b>3.11</b>	<b>1.24</b>	<b>8</b>	<b>284.7</b>	<b>109</b>	<b>12.5</b>
<b>NCS-006</b>	<b>3.15</b>	<b>5.19</b>	<b>1.30</b>	<b>10</b>	<b>320.0</b>	<b>105</b>	<b>10.9</b>
<b>NCS-007</b>	<b>3.10</b>	<b>5.14</b>	<b>1.10</b>	<b>10</b>	<b>330.0</b>	<b>100</b>	<b>11.1</b>
<b>NCS-008</b>	<b>2.60</b>	<b>2.70</b>	<b>1.40</b>	<b>8.9</b>	<b>147.9</b>	<b>90</b>	<b>11.6</b>



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**Sugar research and development at national cereals research institute.**

The dismal performance of the large-scale sugar plants in Nigeria spurred research interest in sugar processing technology to meet domestic sugar requirement and sustainable production at cottage levels in 1986. The journey in this regard started with a – 2 tonnes per day (tcd) capacity, cane crushing prototype brown sugar plant to a 10tcd brown sugar plant (Fig. 1) and to an expeller model designed and fabricated with extraction efficiency of about 98% in 2008 (Figs. 2 & 3).



**Fig 1: Cane Crusher Designed and Fabricated by NCRI for the production brown sugar.**



**Fig 2: Cane Cutter designed and fabricated by NCRI for the production of brown sugar.**

This technology is earnestly yearning for immediate support by wealthy entrepreneurs and other stakeholders in the sugar industry for mass production for sitting in every cane growing community in Nigeria for the attainment of sugar self-sufficiency and for export.

Individuals currently engaged in sugar imports, a practice that is counter-productive to local sugar production and the general industrialization policy of government, should rather invest in it the technology.



**Fig. 3:** Expeller Machine for brown sugar processing.

The technology was promoted by the National Office for Technology Acquisition and Promotion (NOTAP) and installed at Omor, Anambra State, Zaria in Kaduna State, while that installed at Ibaa in Rivers State was not been commissioned.

With the development of the cottage level brown sugar technology by researchers at NCRI, efforts are on by sugar cane farmers at Kona Mada (FCT) Omor (Anambra State), Zaria (Kaduna State) and Ibaa (Rivers State) to cultivate the appropriate sugar cane to feed the plants established

in these locations. These sites have, sugar cane fields ranging from 0.5 – 5.5ha, totaling 115 hectares for cane cultivation (*Ukwungwu et al., 2011*).

The brown sugar processing technology is chosen to be relevant promotion tool for the green field agricultural policy of the Nigerian Government, where its units are expected to be installed in at least 108 Sugar cane growing communities in 14 states of the country. When this is realized, the local sugar production of Nigeria will be boosted with the production of 16,200,000 tonnes of sugar which will reduce direct sugar import figures by at least 8.9% (*Ogunremi et al., 2014*).

Our strength, weaknesses, opportunities and threats (SWOT) in the quest for increased sugar cane and sugar productivity have been as detailed below:

**Strength:** The programme has 5 Ph.Ds, 4 M.Sc.s, 2 B.Sc.s, HNDs and ONDs and relevant certificate holders in research and development on Sugar cane and Sugar Research

**Weaknesses:** The Institute has had no international collaborators /sponsors, no irrigation water, inadequate staff, no support from sugar industry on research and development.

**Opportunities:** With high demand for sugar cane as raw material for sugar and ethanol production and availability of sugar cane experts, the institute is well positioned to deliver to cane growers' needs efficiently.



**Threats:** The placement of the Sugarcane Research Programme in an overstuffed Ministry of Agriculture where specific research requirements/requests are often misunderstood or rejected.

**Major challenges:** The major challenge to the development of new varieties has been the lack of support from the sugar companies. The Sugar cane Research Programme of the National Cereals Research Institute was set up to provide research support to the sugar companies. Research and development effort by the programme to evolve new varieties with natural adaptability to the Nigerian ecosystem were not complemented by the sugar companies as reported by **Allison (1980)**, till their total collapse in the early 21<sup>st</sup> century.

Another challenge has been the lack of viable sugar cane breeding station in Nigeria, because of yet another non-existence of a regulatory body on sugar cane and sugar development in the country. Thus improved technologies of breeding lantern in a glass house or immersing the parents for hybridization in solution has not been feasible. It is therefore not surprising that poly-cross method of hybridization was the main method utilised in the development of most of the released varieties, except NCS 006 and NCS 007 which were developed through mutagenic means.

With necessary prioritized agenda, the Institute gingered the Sugar Cane Research Programme along the sub-programmes below:

- a. Sugar cane breeding and variety improvement to provide high sugar and disease/pest resistant sugar cane varieties.

- b.** Sugar cane Agronomy to provide efficient production and husbandry techniques for sugar cane.
- c.** Sugar cane nutrition and soils to provide appropriate rates, mode and time of application of inorganic and organic fertilizers and the appropriate types.
- d.** Sugar cane protection to provide potent and cost effective pesticides and botanicals to manage pests and diseases of sugar cane.
- e.** Sugar cane processing and utilization to identify various processing machinery for sugar production, suitable clarification agents, by product utilization
- f.** Sugar cane production Economies, to provide maximum beneficial and minimum cost ways of producing sugar cane and identifying market outlets for its various by-products.
- g.** Sugar cane seed production and related projects to provide quality and sufficient seed cane to growers on demand at all times.

Sugar cane is the principal raw material for sugar and ethanol production and needs increased research to identify energy rich cane varieties as well as high sugar content varieties for sugar/ethanol production (*Zuurbier 2008*). With, the renewed interest in the reduction of green house effects provided by ethanol fuels throughout the world, there is need to intensify research on sugar cane with the aim of increasing the per hectare tonnage yield as well as sugar and ethanol yields/ha as reported by *Zuurbier (2008)*. Hence, it is my institute's

urgent need to get needed collaboration in rapid cane variety development through biotechnology as well as cottage level sugar production techniques for increased sugar production in Nigeria.

- i. Output:** It is expected that new cane varieties from the collaboration with Egypt will attain yield potential of 100 -120t/ha.
- ii. Outcomes:** Many cane farmers will have access to the new varieties and production//unit area and yield/ha will be increased.
- iii. Linkage organization(s):** The sugar cane programme had linked with (NOTAP) Renewable Energy Division of NNPC, Sugar estates Dangote Savannanah Sugar Company, Numan, Josepdam Sugar Company Bacita, state government's private companies and Sugar cane Out Growers Association in its quest to attain relevance in sugar cane and sugar to cane growers and the industry.
- iv.** It is at this point that strong collaboration with the Egypt sugar group is advocated especially in the area of sugar cane biotechnology and variety development to augment our infant tissue culture and rapid seed cane multiplication to meet production demands by the new sugar factories.

On a general note, daunted by a weak sugar industry, collaboration has been slim between research and the sugar millers in Nigeria. However, there has been an improved collaborative activity of recent, pivoted by the NSDC as its statutory function in supporting the research and development programmes of institutions working on sugar cane and sugar research. Through the NSDC also cane breeders have been

networked to evolve adaptable high yielding varieties of sugar cane for the sugar industry as indicated above.

As reported by *Jumbe (2007)*, greater research mobilization is needed to develop technologies that will increase productivity of sugar cane production per unit of land and labour, to meet growing global demand for both sugar and biofuels.

Sugar cane agriculture which should be the preserve of NCRI's Sugar cane Research Programme under the Federal Ministry of Agriculture and Rural Development (FMARD), Abuja has not been properly positioned. Hopes are on that in due course, this will be streamlined for effective performance of the sugar cane programme at NCRI. Thus, the special invitation extended to me as the current Chief Executive of the Institute with mandate on sugar cane and sugar Research in Nigeria to this conference is timely, fortunate and is wholeheartedly welcomed.

Before now, the Institute had thrived in the areas of capacity building, building of partnership and collaboration for the attainment of a viable sugar cane and sugar industry as below:

### **Capacity Building:**

Attaining a viable Sugar Industry can only be visible through training and re-training of manpower involved in either sugar cane or sugar production. The Institute benefited from a training organized for personnel from NCRI, USRI and CNRA by NSDC at (*Mauritius in 2010*), which was a good step in capacity building (*Anon. 2010*). This enhanced improvement of the staff in the various disciplines and their skill

and hence improved them in sugar cane and sugar production. Such collaborative trainings are still needed by NCRI with relevant sugar organizations of Egypt.

**Building Partnership through Public Private Initiative (BPPPI):**

Public Private Partnership which is also one of the keystones in building a viable and sustainable industry in a dwindling economy had been tried NCRI in her journey in the sugar cane sugar R & D. The Institute involved governmental, and non-governmental organizations and recorded the modest achievements highlighted in this paper.. Government is, however, required to put up small scale sugar cottage industries in communities where sugar cane (Industrial) is grown on large scale to utilize our brown sugar technology. It is then the duty of such communities to partner with government in the sustenance of the brown sugar production. Community cooperatives can be involved in the sustenance of such projects through the buying and selling of shares and the profit belongs to the same cooperatives leading to a stable and sustainable growth in the cottage sugar industry.

**Collaboration/Training of Sugar Cane/Sugar Scientists/Technologies:**

Another area where infrastructural development can help sustain the sugar industry in Nigeria is in collaboration and or Trainings of different categories. Short training in or out of Nigeria of scientists and technologies involved in the sugar cane/sugar development should be a continuous activity as stressed by *Ogunremi et al., (2014)* and which are reproduced below in this paper.

At this point, NCRI extends its hand of fellowship to Egypt's sugar groups to partner with it to fund relevant trainings that will be worked out

at this conference and will bring about improvement in sugar cane and sugar production in Nigeria.

1. Training and capacity building of breeders/Agronomists in molecular marker assisted selection to accelerate the availability of new cane varieties.
2. Training and capacity building of breeders/pathologist on improved tissue culture techniques to mass-propagate new cane cultivars for nurseries and for elimination of diseases from new cane varieties.
3. Training and capacity building of breeders/protectionists on techniques of molecular characterization of sugar cane germplasm.
4. Training and capacity building of Agronomists on techniques to develop transgenic sugar cane with enhanced nitrogen assimilation capacity to decrease the use of inorganic fertilizers.
5. Training and capacity building on quality seed cane production and management of seed cane nurseries.
6. Training and capacity building of protectionists (Pathologists and Entomologists) on the bio-safety of pesticides and biological control of pests and diseases.
7. Training and capacity building of protectionists on techniques for nematode/disease isolation and identification.
8. Training and capacity building of Engineers/fabricators and technologists on production and processing, machinery designs and fabrication.
9. Training and capacity building of Engineers/fabricators on improved cane-processing techniques.

10. Training and capacity building of Engineers/Technologists on by product utilization.

Training and capacity building of technologists on efficient handling/use of sugar analytical equipment and software.

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## **الملخص العربي**

### **أبحاث قصب السكر فى المعهد القومى لبحوث الحبوب : حان وقت التعاون مع شركات السكر فى مصر**

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المعهد القومى لبحوث محاصيل الحبوب بجمهورية نيجريا الاتحادية هو المنوط بعمليات التربية والتحسين الوراثي لقصب السكر بالاضافة إلى خمسة محاصيل أخرى. وفي هذا السياق فقد ساهم المعهد القومى لبحوث محاصيل الحبوب في عمليات البحوث والتطوير في قصب السكر على مدى الاربعة عقود الماضية. ففي خلال هذه الفترة تم إنتاج سبعة أصناف لزراعتها من قبل شركات صناعة السكر النيجيرية. كما تضمنت الجهود البحثية في مجال تكنولوجيا صناعة السكر زيادة إنتاج وتصنيع السكر البني إلى 10 طن في اليوم. وفي سعيهم لتحقيق تقنيات جديدة فقد تعاون العديد من المساهمين مع الحكومة الاتحادية والهيئات الحكومية على المستوى الفيدرالي والمستوى الحكومى والمحلي والجامعات التي ليس لها أي تمويل من صناعة السكر النيجيرية . بسبب وجود بعض النقص في المجالات الرئيسية لبحوث وإنتاج قصب السكر و تكنولوجيا صناعة السكر فإن المعهد يجد ضرورة للبحث في مصر عن متعاونين جديرين في مجال تطبيقات التكنولوجيا الحيوية في تربية قصب السكر وكذلك تكنولوجيا صناعة السكر لإنتاج أصناف من قصب السكر تكون مناسبة لإنتاج السكر والايثانول، ونرى أنه قد حان الوقت لمثل هذا التآزر. يسلط هذا البحث الضوء على إنجازات المعهد القومى لبحوث محاصيل الحبوب بجمهورية نيجريا الاتحادية خلال العقود الماضية فيما يتعلق بابحاث إنتاج وتربية قصب السكر وتكنولوجيا صناعة السكر وكذلك المجالات التي تحتاج إلى تعاون عاجل مع المختصين في ابحاث إنتاج وتربية قصب السكر وتكنولوجيا صناعة السكر في مصر.