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S&T RESEARCH/INNOVATION IN NIGERIA

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ECONOMIC COMMISSION FOR AFRICA

COMPENDIUM OF SCIENCE AND TECHNOLOGY RESEARCH AND DEVELOPMENT FOR NIGERIA

Country Brief on Food Security and Sustainable Development

1. Population - 88.5 million (1991 Census) males 44.5 million, Female 44 million

2. Land Area (total) - 923,768 sq. km

3. Arable land - 32.3% as % of land areas (1995)

4. Food production per capita index in 1995 (1979-81 = 100): 129

5. Daily supply of calorie per capita (1995) : 2125

6. Yields/hectare of major crops (1994/95)

Crops	Tonnes
Millet	882
Guinea Corn	1,106
Groundnut	917
Beans	458
Yam	10,032
Cotton	1,304
Maize	1,143
Cassava(Old)	9,726
Rice	1,242
Melon	1,,142
Cocoyam	4,262

7. Number and Types of Research Institutions
   - . Industrial - Five
   - . Fisheries & Marine - Three
   - . Food Crops - Five
   - . Tree Crops - Three
   - . Livestocks - One
   - . Medical - One
   - . Agricultural Services - Five

8. Ratio of Scientists, engineers and technologists (1000) 1 per 1000 people (1992)

9. Percentage contribution to GDP by:
   - . Agriculture : 34% (1997)
   - . Industry : 8% (1997)
   - . GDP per capital : US$ 200 (1996)

10. Number of Universities - 31 (1997)
    Technical Institutions - 240 (1997)

11. Environmental Protection
    - . Statute/Law/agency : Federal Environmental Protection Agency established based on constitution.

12. Power Data : Power Consumption : Total units generated : 15.8 million KWH (1995)
    - . Total Power Consumed : 10 million KWH

13. Telecommunications Data
    - . Capacity - 600,000 (1993)
    - . Telephone sets - 405,991 (1995)
    - . Teledensity - 0.2 lines/100 people

1. IMPROVED CASSAVA VARIETY (Commodity)

A. **Brief Background and Problem Specification** : Varietal trials on improved cassava varieties were conducted by the International Institute of Tropical Agriculture (IITA) over a three-year period (1983-1986) at four locations in Nigeria. The research was important because cassava is consumed by most of Nigeria's rural dwellers. Out of Africa's total cassava output of 72.7 million tons, Nigeria produced 35.7 per cent in 1990, making it the largest cassava producer in Africa.

B. **The Innovation Process** : The trials were conducted in four ecological locations namely Ibadan (transitional humid forest zone); Mokwa (Guinea zones); Onne and Warri in the high rainfall zone with poor sandy soils. IITA is a regional institution with considerable financial and technical capacity and as such had no serious financial problem. The ecological spread of the trials ensured the that outcome of the trials were generally acceptable across the country. The variety labelled TMS4(2)1425 was the outstanding variety in the 3-year long experiment. It has a yield of 20.9t/ha compared with the control variety with a yield of 9.9t/ha. The closest varieties had yields of 19.1 and 14.4t/ha but with higher cyanide contents. The outstanding variety had a cyanide content of 3.1mg/110g, while it proved superior to all other varieties in other respects such as high resistance to cassava mosoic virus (CMV) and cassava bacterial blight (CBB) diseases. The tubers are poundable (an important asset) and

has a high garification rate.

C. **Lead Institution** : International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria

D. **Contact Person(s)** : Dr. Alfred Dixon, Plant Breeder, Root and Crop Improvement Program, IITA, Oyo Road, P.M.B. 5320, Ibadan, Nigeria

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E. **Collaborative Institutions** : None

F. **Funding Sources** : International Donors, Nigerian Government

2. Development of Sorghum Varieties (Commodity)

A. **Brief Background and Problem Specification** : Sorghum is a cereal grown in very large quantities in Nigeria. It is a rain-fed crop that grows in all the ecological zones of Northern Nigeria except the swampy areas. The Institute of Agricultural Research (IAR), Samaru of the Ahmadu Bello University, Zaria over years developed about 30 sorghum varieties that are adapted specifically to each of the four savannah ecological zones. The pressure to develop sorghum particularly for malting grew more intense in the mid-1980s with the threat of outright ban on imported malt made largely from barley at the time.

B. **The Innovation Process** : The IAR developed about 30 improved varieties of sorghum that are adapted to each of the four savannah ecological zones. These include: 9-short-season types adapted to the Northern Sudan (including the Sahel and the Sudan Savannah); 5-medium-season types adapted to the Sudan Savannah; to long-season types adapted to the Northern Guinea Savannah; and 5 late-maturing types adapted to the Southern Guinea Savannah areas. The early varieties were progressively replaced by better performing types. Out of the lot were five very high-yielding sorghum hybrids out of which three were subsequently chosen. These 3 had superior characteristics of high yield, disease resistance and suitability for both small to large farm cultivation. The new varieties had average yields of over 40% higher than the elite

varieties. Biochemical tests were carried out on the varieties by which it was confirmed that they were suitable for commercial animal feed and for malting. Physiochemical and biochemical studies on the Nigerian sorghum showed that the optimal seed variety for malting is the SK 5912 (short Kaura) because of properties such as: low tannin levels; good endosperm; low gelatinization temperature; high carbohydrate content; and reasonable protein content.

C. **Lead Institution** : Institute of Agricultural (IAR), Samaru of the Ahmadu Bello University (ABU), Zaria

D. **Contact Person(s)** : Director, Institute of Agricultural, ABU, Zaria

E. **Collaborative Institutions** : Federal Institute of Industrial Research, Oshodi (FIIRO), Lagos

F. **Funding Sources** : Federal Government of Nigeria

3. **Flavouring Condiment Processing (Process/Product Technology)**

A. **Brief Background and Problem Specification** : There are as many traditional processes for preparing indigenous foods and condiments as there are varieties of foods. One of these is the seeds of the fruits of the African locust bean (Parkia Clappertoniana) has been processed to flavouring condiment known as IRU (Yoruba), DOROWA (Hausa) and OGIRI-IGALA (Igbo) in the three major Nigerian languages. The processing technology was based on improved traditional method of producing the condiment.

B. **The Innovation Process** : The traditional method of production involves cooking the raw locust beans in a big earthen pot on wood fire for almost 24 hours. The seed coats are then removed by pounding in mortar and the clean seeds further cooked with processing adjuncts for up to 14 hours. The seeds are subsequently spread on flat calabashes and allowed to incubate for 36-48 hours. Both the FIIRO and Cadbury Plc have established the microbiology of the fermentation as well as the effects of different processing adjuncts on texture, colour and aroma. The major drawbacks of the traditional method was excessive fermentation which leads to proteolytic breakdown of proteins with a resultant off-odour. This was improved upon by controlled germentation. It was also established that IRU of varying characteristics could be produced using their inherent bacteria or by some ubiquitous bacteria like micrococcus or a combination of both. The

product compared well with traditional products in taste and is more hygienic with established accepted organoleptic characteristics. It is produced and distributed in commercial quantities by Cadbury PLC, Nigeria.

C. **Lead Institutions** : Cadbury Nigeria PLC, Ikeja, Lagos; Federal Institute of Industrial Research, Oshodi, FIIRO, Lagos, Nigeria.

D. **Contact Person(s)** : Operations Director, Cadbury PLC, Ikeja, Lagos; Director, FIIRO, Lagos.

E. **Collaborative Institutions** : N.A.

F. **Funding Sources** : Internal sources for both organizations.

4. Yam Pounding Machine (Women and Technology)

A. **Brief Background and Problem Specification** : Yam is an indigenous staple (a tuber) that is cultivated across Nigeria. It is a seasonal crop which tends to rot if not preserved. It is consumed largely by the Yorubas of the Southwest, the Ibos in the East and people of the Middle Belt. Yam is consumed as a sticky mash with sauce. But pounding the yam is a very labourious and difficult process which generates a large volume of sweat. It falls on the women to do the pounding. The yam pounding machine is thus a drudgery-relieving technique, essentially a mechanized mortar and pestle. The industrial sized version has attached to it, a huge basin while the home (portable) version looks like a bread mixer or a large blender.

B. **The Innovation Process** : The original model was developed at the University of Ife, Nigeria by a Professor of Agricultural Engineering in 1976. The model invention took 2 years to develop and the motivation was to make yam pounding less laborious. The work took place in the professor's laboratory and after its feasibility was demonstrated, the inventor produced three models but lacked the finance to produce the machine in commercial quantities. While the invention was sitting in the laboratory in Ife, the Japanese suddenly flooded the market with the yam pounding machine. There were allegations that the Japanese manufacturer copied the Nigerian prototype and took advantage of its solid financial base.

Soon after, the patent for the local prototype was sold to an indigenous manufacturer, Addis Engineering Ltd. who mass produced the machine. Leventis Nigeria Ltd became the corporate entrepreneur distributing the product in all its outlets. Useful user feedback was provided by Leventis Ltd to Addis who in turn used the information to further refine and perfect the product. Additional accessories that Addis added soon gave the Nigerian a competitive edge over the Japanese model. The success of this innovation may be attributed to the fact that it is demand-driven, it has a fairly large market and it was cheap.

C. **Lead Institution** : Obafemi Awolowo University (formerly University of Ife), Department of Agricultural Engineering, Ile-Ife, Nigeria

D. **Contact Person(s)** : Dean, Faculty of Engineering, O.A.U., Ile-Ife

E. **Collaborative Institutions** : Addis Engineering, Lagos (developed prototype and commercialized)

F. **Funding Sources** : O.A.U and Addis Engineering

5. **The Gari-processing Machine (Women in Technology)**

A. **Brief Background and Problem Specification** : Gari is an important staple obtained from cassava. Cassava rots quickly and is difficult to preserve. Cassava could be processed into a flour or into gari (roasted pulp). Gari processing is a long and tedious process. Cassava has to be peeled, washed, grated, pressed, granulated and dry roasted before it becomes edible. Pratically all gari is produced by women and rural women spent a great deal of their time producing it with the traditional, inefficient, manual methods. The need to mechanize the process derive from a need to reduce drudgery so that women will have more time for education and personal development.

B. **The Innovation Process** : Several versions of gari processing machines have been made but the Federal Institute of Industrial Research, Oshodi (FIIRO) has been the most successful in integrating all the various processing stages (except peeling). The grating and pressing is usually combined. In the model using hammer mill pulper, peeled cassava is fed into a hopper where it moves into the milling chamber, milled into a pulp and ejected through an outlet into a perforated basin. A motor-operated pressing block forces the mash against the basin. According to one independent inventor of the machine, the inspiration for the equipment came from a hammer mill. It took a year to produce the first prototype and another year to produce a commercially

acceptable version. Once the efficency and feasibility was demonstrated, the innovator produced more machines which sold quickly. FIIRO has done much to promote the gari processing machine as both a rural technology and drudgery-relieving. However, a number of entrepreneurs have been producing the machine.

C. **Lead Institution** : Federal Institute of Industrial Research, Oshodi (FIIRO), Lagos

D. **Contact Person(s)** : Director, FIIRO

E. **Collaborative Institutions** : Not available

F. **Funding Sources** : The pertinent agencies

6. The Maize Sheller (Women and Technology)

A. **Brief Background and Problem Specification** : Maize is another major staple that supplies majority of Nigerians with carbonhydrates. It is widely cultivated with a high yield per hectare. Post harvest loss could however be considerable and as such shelling, prior to storage and preservation becomes important. Maize is better preserved after shelling and treatment against weevils and other organisms. In practice, it becomes the lot of women and children to shell the crop by hand - a long and tedious manual process. Maize shelling machines therefore remove tedium and drudgery among women and children.

B. **The Innovation Process** : The process leading to the innovation was undertaken within a higher institution. The innovator was an agricultural engineer who had access to workshop and research facilities. This was clearly a demand-pull innovation as testified by the inventor. Two farmers had initially asked for such a device and the engineer had undertaken the design of the machine from first principles. The farmers immediately bought the machines and the sale of about two dozen others followed almost immediately. The machine was quickly adopted and its diffusion led to widespread imitations by other entrepreneurs. The perception of users is that the machine is quite efficient and has resulted in significant growth in output. Users are also persuaded that the process is labour-saving.

C. **Lead Institution** : Obafemi Awolowo University (OAU)

D. **Contact Person(s)** : Dean, Faculty of Technology, O.A.U.

E. **Collaborative Institutions** : N.A.

F. **Funding Sources** : Internal Research Grant

7. **Beer Brewing From Sorghum Malt (Processing Technology)**

A. **Brief Background and Problem Specification** : Lager beers are traditionally brewed from barley malt. The malt is produced by steeping the grain in water, allowing it to germinate, drying it in kilns, and grinding it into flour. Reduced earnings from oil exports had put pressure on imports including barley imports. This induced research into local alternatives to barley malt and by both the Federal Institute of Industrial Research, Oshodi (FIIRO) and the Project Development Agency (PRODA) Enugu.

B. **The Innovation Process** : Research and development of sorghum malt started in the 1970s in Nigeria. The Brewing Industry Research Foundation, Nutfield, England developed a malting and brewing equipment for FIIRO in 1976 sequel to which significant progress was made. Seven sorghum cultivars were malted and the malts were thereafter combined to create one portion of sorghum-barley composite malt. In the end, short Kaura sorghum (SK 5912) was chosen as a result of the tests. The malt worts and the beers were fully analyzed and was found to be acceptable lager with a shelf life of 26 weeks. By the mid-1980s, commercial production of sorghum malt beer was been produced by major brewing companies that were initially hostile to the whole idea. Production was initially based on gradual replacements at 25%, 50%, 70% and eventually 100%. The cirteria for market success were: taste, flavour, aroma, after-palate strength, aftereffect, clearness and foaminess.

The tests were carried out at all the major beer-consuming cities of Nigeria. Initial resistance had come from established brewers who argued that sorghum was different from barley in chemistry, taste, stability, fat, tannin and nitrogen contents. Technically, they argued, the beer could not be called lager. The fear, it would seem was the risk of basing a major investment on laboratory/pilot tests of a process that was new.

C. **Lead Institution** : FIIRO, Lagos, Nigeria; PRODA, Enugu, Nigeria; All the major brewers in Nigieria

D. **Contact Person(s)** : Director, FIIRO, Lagos; Director, PRODA, Enugu; Managing Director/CEO, All Major Breweries

E. **Collaborative Institutions** : As in C and D

F. **Funding Sources** : Institutions listed in C and D

8. Palm Wine Production (Processing Technologies)

A. **Brief Background and Problem Specification** : Palm wine is an alcoholic beverage tapped from fresh palm and raphia trees. It is traditionally taken fresh and unprocessed and as such did not need to have a long shelf life beyond a few hours. It was the major alcoholic drink in southern Nigeria before the introduction of lager beer. It remains an important ceremonial and daily drink for rural dwellers. The basic objective of bottling palm wine is to reduce its high perishability rate and give it a long preservation.

B. **The Innovation Process** : The heart of the process is pasteurisation and as such the equipment consists of a pasteuriser with heating elements, thermostat, pumping system for water circulation, bottling and corking equipment. The pasteuriser was designed and fabricated by FIIRO, followed by PRODA and subsequently adopted by the National Institute for Oil Palm Research (NIFOR), Benin City. Other companies have since imitated and improved upon the original design. FIIRO promoted this technology by selling the equipment and by training potential entrepreneurs. The key success factors in the diffusion of this technology are that it is sold as a complete package and users therefore do not have to engage in significant development efforts. It is relatively cheap and affordable for small entrepreneurs. In addition to extending the shelf life to 6 months, the drink retained its natural taste. At the early years of this innovation, an average of

6 to 7 bottling companies were being established every year.

C. **Lead Institution** : Federal Institute of Industrial Research, Oshodi, FIIRO, Lagos

D. **Contact Person(s)** : Director, FIIRO, Lagos

E. **Collaborative Institutions** : PRODA, NIFOR in different cities in Nigeria

F. **Funding Sources** : Federal Government of Nigeria

9. Development of Soy-ogi : Infant Food (Processing Technologies)

A. **Brief Background and Problem Specification** : Soy-ogi is a protein-fortified carbohydrate pap for infants and adults, produced primarily from maize, guinea corn (sorghum), soya beans, vitamins and minerals. Traditionally, pap is made from maize or guinea corn or soya beans in different parts of the country with a shelf life of about 3 days. It is laborious and time-consuming. With the innovation, the shelf life is extended to one year, the advantage of quick and instant preparation and fortification of a purely carbohydrate food with vitamins and minerals. It is both a response to the need of low-income earners and a solution to the problem of poor nutrition.

B. **The Innovation Process** : Work started on the project in the early 1970s and the food product was first test marketed in 1972-73. Early efforts were pioneered by the Federal Institute of Industrial Research Oshodi (FIIRO). There were early complains of possible toxicity but the issue was readily resolved but large-scale production did not come easily. It was expected, given discussions with Nestle, that the product will be taken up by one of the big companies. FIIRO continued to produce and market it from its pilot plant for more than a decade. However, with a more difficult fiscal regime, some indigenous companies took up the challenge and have since been producing the baby food.

C. **Lead Institution** : Federal Institute of Industrial Research, Oshodi, FIIRO, Lagos

D. **Contact Person(s)** : Director, FIIRO, Lagos

E. **Collaborative Institutions** : Not Available

F. **Funding Sources** : Federal Government of Nigeria

10. Scientific Equipment Development Institute (SEDI) (Infrastructure for Science Equipment)

A. **Brief Background and Problem Specification** : The Scientific Equipment Development Institute (SEDI) formerly Federal Science Equipment Manufacturing Centre is one of the agencies of the Federal Ministry of Science and Technology. The mandate of the Institute is to develop scientific equipments that could be products or processes and thereafter engage private entrepreneurs to mass produce them.

B. **The Innovation Process** : This is a case of an institutional innovation that was necessitated as a result of failure in the area of science equipment production market. Nigeria was expending considerable amounts in the importation of scientific equipment and machinery as well as spare parts and components. This was the main motivation for establishing the SEDI. The factory was designed and built in Nigeria to cater for secondary school science equipment particularly in the areas of Physics, Chemistry, Biology, Integrated Science, Agricultural Science and Mathematics. The success of this institutional innovation is borne out by the relatively rapid rate at which SEDI has perfected the technology for the manufacture of more than 230 items of science equipment such as thermometers, potentiometers, condensers and rheostats among others. The products of the Institute have been adjudged to be of international standard and the price highly competitive. More than twenty new products such as microscopes, digital timers, soil moisturimeter and others

have been commercialised. The Institute provides nationwide advisory service for maintenance and sourcing of spare parts and components.

C. **Lead Institution** : SEDI, Enugu, Nigeria

D. **Contact Person(s)** : Director, SEDI, Enugu, Nigeria

E. **Collaborative Institutions** : Federal Ministry of Science and Technology (FMS&T), Abuja

F. **Funding Sources** : Federal Government of Nigeria