

**University-firm interaction in sub-Saharan Africa:
evidence from case studies of university practice in
Nigeria**

John O. Adeoti, Kolade Odekunle and Foluso Adeyinka
Nigerian Institute of Social and Economic Research (NISER), Ibadan, Nigeria

Working Paper*
1 November 2008

IDRC Project Number: 103470-009

IDRC Project Title: Knowledge for development: University-firm interactions in sub-Saharan Africa

Country/Region: South Africa, Nigeria and Uganda

Lead Research Institution:

Human Sciences Research Council
Private Bag X9182
Cape Town 8001
South Africa

Lead Research Team:

Glenda Kruss, Jo Lorentzen, Il-haam Petersen (HSRC)
Dani Nabudere, Babuuzibwa Luutu, Edgar Tabaro, Dani Mayanja (MGPARI)
John Adeoti, Kolade Odekunle, Foluso Adeyinka (NISER)

Contact Information of Research Team Members:

South Africa: gkruss@hsrc.ac.za
Uganda: nabudere@gmail.com
Nigeria: adeotij@yahoo.com

*This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

TABLE OF CONTENTS

ABSTRACT.....	ii
Introduction.....	1
Research methodology.....	2
Case study 1: University of Agriculture, Abeokuta.....	3
University vision and mission.....	3
Institutional conditions and structure for research.....	5
The Research and Development Centre (RESDEC).....	5
The Biotechnology Centre.....	8
Agricultural Media Resources and Extension Centre (AMREC).....	11
Research in agro-food processing.....	13
UIL cases.....	16
UNAAB-Nestle soyabean popularization and production project.....	16
Cassava flash dryer project.....	20
Biotechnology and UILs.....	23
Case study 2: Federal University of Technology, Akure.....	24
University vision and mission.....	24
Institutional conditions and structure for research.....	26
Center for Research and Development (CERAD).....	27
The Business Development Company (BDC).....	29
Research in agro-food processing.....	29
Post-harvest technology programme.....	30
Design and fabrication of solar dryer.....	31
Design and fabrication of a de-stoning machine.....	31
Design and fabrication of a maize de-husking machine.....	31
Waxing effects on the physical and biochemical characteristics of oranges.....	31
University-industry linkages (UILs).....	32
UIL case of the Grand Cereals and Oil Mills Limited (GCOML).....	33
Case study 3: University of Ibadan, Ibadan.....	34
University vision and mission.....	34
Institutional conditions and structure for research.....	36
The university mission research programme.....	36
MacArthur research capacity building programme.....	39
Research in agro-food processing.....	40
An emerging framework for UILs.....	42
Existing UILs.....	42
Centre for Entrepreneurship and Innovation.....	45
Conclusion.....	46
References.....	49
Appendices.....	50
Appendix 1. Case study research instruments.....	50
Appendix 2. List of stakeholders interviewed.....	50
The case of the University of Agriculture, Abeokuta.....	50
The case of the Federal University of Technology, Akure.....	50
The case of the University of Ibadan, Ibadan.....	51

ABSTRACT

This study examined university-firm interaction from the perspective of three Nigerian universities: two specialized universities (one university of agriculture and one university of technology) and a conventional university. The case studies illustrate the state and intensity of knowledge intensification in agro-food processing in Nigeria, and the contribution or otherwise of university-industry linkages (UILs) to the knowledge requirement for the development of agro-food processing. The findings of the study revealed that the universities have distinguishing features in their research culture and vision; and the state of knowledge intensification in agro-food processing in the three universities differ considerably as demonstrated by the nature and extent of UILs that were identified. The evidence of university-firm interactions confirms that UILs in Nigeria are rare. The university and firm officials interviewed emphasized the constraints on UILs and the challenges posed by those constraints. The constraints identified may be classified into three categories: infrastructure, policy and attitudinal. Infrastructure-related constraints include poor research facilities and equipment, poor electric power supply, poor access roads and communication infrastructure. Policy issues that constrained UILs include lack of incentives, poor government support for industry R&D, and poor funding of research. Attitudinal issues that constrain UILs include lack of political will to address R&D challenges, entrepreneurship culture that lack support for R&D, and divergent views emanating from the mindsets of scientists and industrialists.

Keywords: university-firm interaction, agro-food processing, R&D, industry, Nigeria

INTRODUCTION

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]



RESEARCH METHODOLOGY

From the foregoing, the main research question for the UIL case studies in the context of Nigeria is: what are the constraints on and opportunities for the knowledge-intensification of firms in the agro-food processing sector through interaction with universities? Specific research questions include:

- What is the main mode or channels of interaction, in terms of knowledge intensity?
- What are the outcomes of this interaction, that is, does the interaction work/succeed or not?
- What are the conditions in the university that facilitate and/or constrain this un/successful interaction?
- What are the conditions in the firm that facilitate and/or constrain this un/successful interaction?
- What are the policy conditions and government mechanisms that facilitate or constrain UILs?

The empirical entry point to identify cases of interaction is the university, and the *unit of analysis* is the university-firm interaction. Nigeria is the largest African country in terms of population size and its National Product is second only to South Africa in sub-Saharan Africa. According to JAMB (2007), Nigeria has 81 universities comprising 25 Federal Universities owned by the Federal Government, 28 State Universities owned by the State Governments, and 28 Privately Owned Universities, most of which are relatively young (established within the last five years). The oldest universities are among the Federal Universities and they are considered to be relatively better equipped due to the support of the Federal Government. Thirty of the universities have a department of food science and technology. Eight of these food science and technology departments are in universities located in Southwest Nigeria. Due to limited resources available for the study, the case studies were restricted to universities in Southwest Nigeria (akin to the firm survey). Since the sectoral focus of the study is agro-food processing, we selected four out of the eight Southwest universities that have a department of food science and technology. The four universities selected comprise two specialized universities and two non-specialized universities.¹ The common feature of the four universities selected, is

¹ From the information presented in JAMB (2007), there are 53 public universities in Nigeria comprising 14 specialized universities and 39 non-specialized universities. The specialized universities include three Federal Universities of Agriculture, six Federal Universities of Technology, and five State Universities of Technology.

that they have relatively well-established food science and technology departments that are known to carry out significant research activities. The universities are:

- i) University of Agriculture, Abeokuta (UNAAB);
- ii) Federal University of Technology, Akure (FUTA);
- iii) University of Ibadan, Ibadan (UI); and
- iv) Obafemi Awolowo University, Ile-Ife (OAU).

The preliminary visits to these universities initially suggested that they would cooperate and volunteer information and data required for the study. However, the subsequent fieldwork was confronted with reluctance by the department of food science and technology at Obafemi Awolowo University to cooperate. We eventually decided to drop the university since all attempts and repeated visits to the institution could not produce sufficient information/data for the study. In effect, our focus for the case studies became three universities comprising: one university of agriculture, one university of technology, and one non-specialized university in Southwest Nigeria.

As the starting point, formats and schedules for the collection of data/information on the current state of research on agro-food processing in these universities were designed for the African regional study (see Appendix 1 of UIL case study research instruments). We set out to use these research instruments with minor modifications, as appropriate for the Nigerian context. The Head of Department (HOD) of Food Science and Technology at each of the universities was selected as the focal point and lead informant that serves as facilitator of interviews and data collection in the university. We focused mainly on research activities within the last three years to minimize the problem of memory loss. We interviewed the key researchers and stakeholders involved in specific research including either linkages with industry or present indications of the possibility of such linkages. Where UILs are identified, they are treated as the unit of analysis. In addition to obtaining information from secondary sources, the key actors, especially the researchers and firm managers, were interviewed to provide detailed insight into the constraints on and incentives for the UILs. Data and information on the university research mission, vision, and structures supporting research were also collected alongside interviews of key managers of research and innovation activities at the selected universities. The interview process was guided by the relevant schedule designed for the case studies. In almost all cases, securing an interview appointment was an arduous task. In some cases it took several repeated visits and/or telephone calls. However, once the interview was in process, most of the respondents became enthusiastic and provided useful data/information. The only exceptions to this were the firms identified for the UIL cases. Compared to the university officials, the firms were reluctant to provide information by interview.

CASE STUDY 1: UNIVERSITY OF AGRICULTURE, ABEOKUTA

UNIVERSITY VISION AND MISSION

The University of Agriculture Abeokuta (UNAAB) is one of the three Universities of Agriculture established in 1988 by the Federal Military Government of Nigeria.²

² While UNAAB was sited in Southwest Nigeria, the other two universities are located in Makurdi, Benue State (Northern Nigeria) and Umudike, Abia State (Eastern Nigeria). UNAAB was established in January 1988 and started operation at its mini-campus at the then College of

According to UNAAB (2007), the founding of the universities of agriculture was aimed at promoting agricultural education and services for agricultural development, and thereby, serve as an important instrument of the attainment of self-sufficiency in food and fibre. The enabling statute of the university listed thirteen specific objectives of the university.³ The objectives may be summed up as a decomposition of the traditional view of universities having a mission of teaching, research and extension. In the view of Oyewole (2008, p.19), the mission of the university can be stated as follows:

- Production of high level manpower in the fields of agriculture, veterinary medicine, sciences, engineering, environmental sciences and allied disciplines.
- Innovative agricultural research and development aimed at the modernization of Nigerian agriculture.

From the interviews conducted with principal officers of the university, most of the respondents pointed out that UNAAB is currently under reform. It is in the process of being transformed into an institution with clear and well articulated vision and mission statements that would be widely advertised and on display at strategic locations within the university community. According to Oyewole (2008), the present Vice Chancellor of the university has made a commitment to 'make this university (UNAAB) the leader among specialized universities in Africa with satisfactory global rating'. Although this is short of a vision for the university, it is akin to a vision statement which could be refined and developed into a vision for UNAAB.

UNAAB has seven colleges and a postgraduate school. The university had 408 academic staff members and nearly 7,000 students in 2007. Table 1 presents the breakdown of the university staff and students according to gender.

Table 1. Distribution of UNAAB staff and students by gender in 2007

	Male	Female	Total
Academic staff	306	102	408
Senior non-academic staff	272	208	480
Junior non-academic staff	318	125	443
Students	4494	2352	6846
Total	5390	2787	8177

Source: Oyewole (2008)

Science and Technology, Abeokuta (COSTAB), which was converted into UNAAB. In December 1997, the university moved to its permanent campus located on 10,000 hectares of land, 15km from the city centre (Oyewole, 2008).

³ See the section on the 'Establishment and Object of Universities of Agriculture' in Decree No.48 of 1992 presented in UNAAB (2007) as The University Act.

⁴ The colleges are: college of agricultural management, rural development and consumer studies (COLAMRUCS); college of animal science and livestock production (COLANIM); college of plant science and crop production (COLPLANT); college of environmental resources management (COLERM); college of natural sciences (COLNAS); college of veterinary medicine (COLVET); and college of engineering.

INSTITUTIONAL CONDITIONS AND STRUCTURE FOR RESEARCH

As a science-based specialized university, UNAAB prides itself as an institution that promotes science and technology. To this end, research and development (R&D) activities are considered as priority in making the university an important source of technological knowledge. The university has three centres which are devoted to issues that are related to R&D activities. These centres are:

- Research and Development Centre (RESDEC),
- Biotechnology Centre, and
- Agricultural Media Resources and Extension Centre (AMREC).

These three centres are located in the same office complex and are each headed by a Director who is a professor appointed by the Vice Chancellor. Each centre has its own staff and the director of each centre reports directly to the office of the vice chancellor.

The Research and Development Centre (RESDEC)

In 1990, the Governing Council of UNAAB established the Research and Development Centre (RESDEC) with a research policy board and a R&D management committee. As stated in UNAAB (2007, p.67), the vision and mission of RESDEC are:

Vision statement:

'the Research and Development Centre is committed to being the synergy and moving force of research in the university'.

Mission statement:

'The Research and Development Centre's mission is to strengthen the research capacity of this university community by encouraging and promoting research that will meet the mandate of the university and promote intellectual and national development'.

The RESDEC has four main functions which include:

- i) organization, coordination, control and monitoring of research activities in the university,
- ii) funding of research and training activities,
- iii) funding of learned conferences, seminars and workshops, and
- iv) promotion of linkages with external support institutions and soliciting for external funding.

For effective execution of its mandate, RESDEC is assisted by the research grants committee comprising of one representative from each of the colleges, the library and the bursary. RESEDEC also prepares the university research budget with inputs from the colleges. An in-depth interview of the director of RESDEC provides further insights into the current operations of RESDEC, and its challenges and strategies for forging and realizing a more focused and well defined vision and mission. Presented below, in Boxes 1-3, are the findings of the research team's interactions with the director of RESDEC.

Box 1. RESDEC and the university vision and mission

- UNAAB is a land-grant university, one of the three universities set up to accelerate agricultural productivity, and to raise agriculture from the level of peasantry and subsistence to a level of significantly increased output and value-addition through agro-processing. The aim is to raise agriculture from the predominantly peasant status to the industrial/business status. This university has a tripod mandate: to teach, conduct research and extension services. By being a land-grant university, UNAAB is expected to create impact in its immediate environment.
- RESDEC has the major responsibility of helping the university to focus research on important themes, monitor and make sure that its research addresses issues that are relevant to Nigeria's development. RESDEC ensures that research in this university remains relevant and that the university delivers services according to its mandate.
- The research vision of the university is to carry out research for development. The mission is to build entrepreneurship into research activities in the next three years. We hope to achieve a marriage between science and entrepreneurship in the next three years. For the next three years we aim to be driven by the spirit of enterprise to realize the vision of research for development.
- UNAAB is already 20 years old, and is currently doing a rethinking of its programmes and mission. The university is adjudged to have done well in the past years, but has a challenge to do better. RESDEC is open to partners willing to discuss how to improve research performance. UNAAB is at the stage of strategizing, and looking for partners that would support research.

Source: Field interview

Box 2. Funding and research administration

- The Federal Government is the major financier of research at UNAAB. Little funding is obtained from third parties, such as, international donors. At least 80% of research funds are from the Federal Government.
- RESDEC manages the university's institutional research funds. The university has about 500 scientists. RESDEC receives research proposals from researchers/scientists from the colleges (i.e. faculties) and the number funded is often dependent on the availability of funds. The proposals are subjected to peer review. Research funds are allocated according to available resources, and efforts are made to spread available fund across the colleges. Some good proposals are unable to receive funding due to paucity of funds available for research.
- RESDEC plans to have priority research themes, possibly beginning from next year. Funding of research would then also depend on how many are able to present proposals that address the university's priority themes. There would be a shift to the concept of mega grants. Mega grants would be allocated to interdisciplinary research projects that address real development challenges. This may result in few but better funded research projects.
- Two key parameters determine proposals to be funded by RESDEC. These include: i) impact potential, which indicates the adoption potential, i.e. whose life would be changed by the research outcomes, will it make production cheaper or increase productivity? This is important because,

though we also support basic research, our research mission is primarily for development; ii) demand-driven research which clearly indicates that there is a development problem to be solved. Many proposals do satisfy these two main parameters. Proposals are often turned down because of lack of funds rather than lack of quality or substance. We sometimes improvise and help researchers organize their research to suit the funds available. We, nevertheless, are able to fund only about 50% of the proposals. We keep others in view either for representation or in our custody for the next round of grants.

- RESDEC has a monitoring and evaluation programme for its funded research. There are records of progress of each of the research projects. We also hold meetings where the grantees discuss the progress of their research projects. Researchers that are highly successful are celebrated while laggards are encouraged and helped to improve the performance of their research.
- Research funds come into the university at two levels: institutional grants or funds dedicated to sponsor research in the university, and individual grants obtained by researchers from external sources. RESDEC administers the former, while the latter is administered by the individual researcher, with a certain proportion (10%) deducted by the university as administrative charges. Institutional research funds first go to the office of the Vice Chancellor from where it is directed to RESDEC (for research) or AMREC (for extension) or Biotech Centre (for biotechnology).
- The colleges are generators of ideas on limited scale because most of their research is student-based. RESDEC supports research proposals that scale up the research ideas emanating from teaching and student-based research activities. There are three key issues that determine the development impact of a research project: Is it possible and practicable? Is it profitable? Is it sustainable? Colleges only ascertain whether the research idea is possible. RESDEC takes up the idea and ascertains whether it is practicable by scaling it up into a development-oriented interdisciplinary research project. If it is considered practicable, then AMREC takes it up as a pilot project. If it is successful at the pilot stage, then AMREC takes it to the end users, who may adopt the research product. With the end users, it is open to modification, scaling up, or even outright rejection after trial. AMREC serves as the channel of feedback between RESDEC/researchers and the end users. RESDEC is responsible for priority setting in research and for verification of claims when feedback is provided by AMREC at the pilot demonstration and adoption stages. The main target of RESDEC is to attract industry into what is going on at UNAAB so that they can partner with UNAAB in supporting research that is development oriented.

Source: Field interview

Box 3. Constraints on university-industry and strategies for forging ahead

- Main constraints on university-industry collaboration: We are yet to win or earn the confidence of industry. Industry is for business. Even when they think of philanthropy or corporate social responsibility they are driven by profit motive. Research projects need uninterrupted power supply. Our university has not reach a stage of uninterrupted power supply. With respect to competence we have it. Industry source for research from outside the country. This is undermining the Nigerian economy. Industry should be patriotic in behaviour by contributing to research in the community that gives them profit. Research may not yield profit but industry can also benefit from the competence of local scientists if they support research. They could support research by providing endowments for research chairs or by donating research equipment (e.g. AAS, Amino-acid analyzer, etc.) to UNAAB. Scientists would work and industry would be able to benefit from the outcomes of local research. For example, Guinness has been able to save foreign exchange on importation of raw materials after the adoption of a locally invented malting line that uses sorghum. The Guinness malting plant was developed at IAR, ABU, Samaru, Zaria in the mid 1980s.
- UNAAB has an intellectual property right office established this year under RESDEC. The office will help researchers to patent their inventions. Before now, scientists do patenting by themselves. The operation of the new office would make patenting less expensive and faster.
- RESDEC currently operates at 25% capacity, in terms of manpower requirements, due to limited resources. Some university departments do not have representatives at RESDEC. When full blown, RESDEC would have capacity to support and monitor research in every department in the university; and would be able deliver high profile results to funders of research activities. With full capacity of manpower at RESDEC, it would also be possible for RESDEC to take the lead in research without taking too much from lecturers' teaching time.

Source: Field interview

The Biotechnology Centre

Biotechnology Centre was established in 2001. From the field interview, it was reported that the biotechnology centre was the outcome of the success of a practical course in modern biotechnology conducted by the Department of Food Science and Technology (DFST) in 2000. After the course, the biotechnology development programme of the university was started under the Equipment Maintenance Centre (EMC) that houses centrally used research equipment. The EMC then became the Biotechnology and Equipment Maintenance Centre (BEMC). In 2001, the Biotechnology Centre was separated from the BEMC and thus become an independent centre for research on modern biotechnology. It was established to provide central biotechnology laboratory facilities to the colleges in the university. Prior to the year 2000, the growing importance of biotechnology in agricultural sciences resulted in the formation of a 'biotechnology group' within the university. The group consisted of about 20 scientists who organized biotechnology seminars and short courses for themselves and other interested scientists. The activities of this group of scientists apparently influenced the creation of the biotechnology centre in 2000. The centre also advises the university on issues of

biotechnology and external linkage and support for biotechnology research and training. (UNAAB, 2007).

According to the Biotech Centre (2007, p.3), the vision of the centre is:

to be the melting pot for biotechnology research and training in Nigeria and the West African sub-region, getting more and more Nigerian scientists to adopt modern biotechnology/molecular methods in the resolution of their research problems for a better fed, healthier, environmentally safer, more innovative and greater Nigeria'.

The centre undertakes biotechnology research and coordinates all biotechnology-related research and training activities in the university. It organizes training courses, workshops, symposia and seminars on biotechnology for the university community and interested persons in the public and private sectors. The centre has its own staff and is headed by a director who is responsible to the Vice Chancellor (VC). The personnel of the biotech centre include, the director, twelve associate scientists appointed from different departments in the university, one technologist for laboratory activities and two secretarial staff. Visiting professors are invited from foreign universities twice a year to run practical courses during the biotechnology training programmes. The visiting professors are supported by the Academy of Science for Developing Countries (formerly TWAS⁵). The Biotech Centre (2007) identified the present constraints on the centre to include:

- inadequate operating space;
- inadequate power supply, especially for sensitive enzymes;
- insufficient laboratory equipment;
- lack of funds for laboratory consumables; and
- inadequate funds for research and training.

Boxes 4-6 present the findings from an extensive interview of the director of the biotechnology centre.

Box 4. Biotech Centre and linkage with industry

- The Biotech Centre has no relation with industry. The director of the centre believes that industrial firms do not support or interact with Nigerian researchers. She claimed that the firms prefer to do their research abroad because they do not believe in the ability of Nigerian scientists to address their problems. The biotech centre has had no collaboration with industry. She expected industries in Nigeria to have assisted in setting up the biotechnology laboratory so that the biotech centre can assist them in solving their problems. She claimed that many of the big firms prefer to do their research abroad and hence they don't have to invest in research in Nigeria. To be fair to these firms, some researchers have disappointed them in time past. For instance, they give out money for research, but could not get value for money.

⁵ TWAS is the Third World Academy of Science.

Box 5. Palm wine research and firm spin-off

- The director of the Biotech Centre has researched extensively on palm wine refining and the production of non alcoholic beverages from palm sap. This involved investigation into improved formulation and blending of palm wine. Palm sap is the exudates of palm. It is non alcoholic but ferments rapidly. If sterile instruments are used to collect the sap, it can stay for about 6 hours without fermenting. However, if it is collected with the normal palm wine taper's funnel and gourd (these have heavy layers of microbial load), it will begin to ferment as it is coming out of the funnel. The professor has developed a way of processing the sap so that the product is non alcoholic, and also claimed to know how to achieve the same result using modern molecular biology. However, the molecular biology method has not been explored because of the unavailability of the needed equipment. The non-molecular biology alternative, though a longer process, was explored. It achieved a remarkable success and the result has been patented in Nigeria at the Federal Ministry of Commerce and Industry. The commercialization of this patent can result in the production of sparkling and table wines from palm wine.
- An aspect of the research product involved the bottling of palm wine. She discovered that this could be done on a very small scale and commercialized. She started the bottling of palm wine at home, for sale to the university community. Her former employer, NIFOR in Benin (Nigerian Institute for Oil-Palm Research), developed the bottling process and taught her how to bottle palm wine. She improved the palm wine formulating and blending process. She developed a formula which is used for the formulation and blending, but the heat treatment that preserves the palm wine was not developed by her. Most of the improved process was developed in the course of her PhD as a staff of NIFOR. The outcome was commercialized at UNAAB first as a small-scale home production, and later set up the bottling unit of the palm wine processing plant of the university.
- There was an exhibition of research results during the university's 10th anniversary at which she displayed the bottled palm wine. The Vice Chancellor took instant interest and the university gave her an enterprise grant of N50,000 to begin commercial production in 1998. The Vice Chancellor (VC) specifically requested her to bottle the wine for the then ongoing celebration of the 10th anniversary of the establishment of UNAAB in 1998. With her consent, the production of the wine was later moved from her house to the university industrial centre in 2005. She helped established the palm wine production plant which was producing about ten crates (250litres) per day. The plant is still a cottage plant. She made the proposal for the planting of upland raffia palms to feed the palm wine bottling firm because inadequate raw material supply has been the major hindrance to the up-scaling of the plant. Raffia palm produce more sap than the oil palm. Wine from the oil-palm trees is presently bottled. For a big bottling plant, a plantation of raffia palm ('Ogoro') is necessary.
- To encourage spin-offs in biotechnology research, the basic philosophy is entrepreneurship. The students should be trained to be self-employed. They should not always look for somebody to employ them, they should aim at employing other people. If students get the right training and encouragement, they will discover that biotech is something that can easily give them a one-room industry that can generate products worth millions of dollars.

Box 6. Weak support from related public institutions

- The National Biotechnology Development Agency (NABDA) was established in 2001 to implement the National Biotechnology Policy and promote biotechnology development. The officials of NABDA have benefited severally from the training programmes of the biotech centre. However, NABDA's support to the centre has been limited. For example, NABDA would be paying for the conference bags to be distributed to the participants in the 2008 Conference of the Nigerian Biotechnology Society, hosted at UNAAB by the biotech centre. As a policy agency, NABDA is restricted by government's programme on biotech development. For example, NABDA could not select the Biotech Centre as one of the proposed National Centres of Excellence in Biotechnology because the Federal Government decided that the centres of excellence should be located in the oldest universities in the six geopolitical zones of Nigeria. This makes the University of Ibadan the centre of excellence for Southwest Nigeria.
- The Federal Ministry of Science and Technology established the Sheda Science and Technology Complex (SHESTCO) as a centre of excellence for scientific research in the pure sciences, since the mid 1990s. SHESTCO has an advanced biotechnology laboratory equipped with modern facilities (see Adeoti and Adeoti, 2005). In the early days of the Biotech Centre, the director made several efforts to get assistance from SHESTCO and to collaborate on training workshops for capacity building. However, SHESTCO did not respond favourably.
- The federal government is not supporting research sufficiently. Universities all over the country are poorly funded for research. Nigerian policy makers want everything to be 'cash and carry'. However, education and research cannot be treated as a commodity subject to 'cash and carry'. Scientific research may fail severally or take a very long time to achieve economically beneficial results. The government of Nigeria is not yet prepared to provide adequate and enduring support for research. Until this is done, research can not proceed to the point of breakthroughs.

Agricultural Media Resources and Extension Centre (AMREC)

About three years after the founding of UNAAB, the Agricultural Media Resources and Extension Centre (AMREC) was established in 1991. AMREC is the outreach and extension agency of the university. It has the mandate to carry out extension services and provide specialist support to the Agricultural Development Programmes (ADPs) in the eight states located in the Southwest farming zone.⁶ According to AMREC (2007), the specific objectives of AMREC are to:

- i) conduct training, workshops, seminars and conferences;
- ii) publish educational and extension-related materials for information dissemination;
- iii) conduct on-farm adaptive research (OFAR), and disseminate research findings and new technologies developed or fine-tuned by the Research and Development Centre (RESDEC) of the university;

⁶ Nigeria has 36 States a Federal Capital Territory. The southwest farming zone is defined by ecological considerations and comprises these states: Lagos, Ogun, Oyo, Osun, Ekiti, Ondo, Edo and Delta.

- iv) translate agricultural findings/technologies into transferable forms using printed and audio-visual media/materials;
- v) coordinate and supervise all technology transfers (extension/OFAR), adult training and outreach programmes of the university;
- vi) provide communication support facilities for teaching, research and extension activities;
- vii) collaborate with research institutes to train the staff of ADPs; and
- viii) demonstrate proven and adaptable production and processing technologies to end users.

AMREC has two categories of extension staff. The first group comprises of the technical extension subject matter staff with specialization in different fields of agriculture such as, animal production, fisheries, food processing, and household economy. The second category is the academic subject matter research and extension staff, also with specialization in different fields of agriculture but with a much higher capacity for research and on-farm demonstrations. The activities of the centre are classified into five programmes comprising:

- Extension and adaptive research;
- Media and farm broadcast;
- Gender issues and youth development;
- Planning, monitoring and evaluation/information and communication technology; and
- Training and farm demonstration.

Table 2 presents the details of the areas of focus of the programmes.

Table 2. AMREC programmes' focus areas

Programmes	Area of focus
Extension and adaptive research	i) Arable crops
	ii) OFAR/extension services
	iii) Input sourcing and procurement
	iv) Agro forestry
	v) Seeds and seedling procurement
	vi) Preventive/healthcare/livestock prevention
	vii) Freshwater/aquatic management
	viii) Fisheries management
Media and farm broadcast	i) Maintenance and repairs and media equipment/facilities
	ii) Audio-visual production
	iii) Extension communication services
Gender issues and youth development (GI&YD)	i) Health extension services/literacy and advocacy
	ii) Storage, processing and utilization of agricultural produce
	iii) Schools outreach programmes
	iv) Cooperatives and group formation
	v) Gender and youth development issues
Planning monitoring and evaluation/Information & Communication Technology (PME/ICT)	i) Diagnostic surveys
	ii) Extension activities monitoring and evaluation
	iii) Statistics and record keeping
	iv) Data analysis/interpretation
	v) Market price surveys and analysis
	vi) Use of ICT in agriculture
Training and farm demonstration	i) Agricultural training/workshops
	ii) Establishment of plantations/demonstration farms

Source: AMREC 2007 Annual Report

The centre is headed by a director who is a professor and is directly responsible to the Vice Chancellor. Each of the programmes is managed by a programme leader. In 2007 the centre had 23 members of staff comprising the director, 15 extension officers and fellows for programme implementation, and seven administrative staff working under the office of the director.

RESEARCH IN AGRO-FOOD PROCESSING

As earlier mentioned, the University of Agriculture, Abeokuta (UNAAB), was one of the three universities of agriculture established by the Federal Government of Nigeria in 1988, with a tripodal mandate of teaching, research and extension services, focused on agriculture and related disciplines. In accordance with its mandate, research activities at UNAAB are generally in the field of agriculture, of which agro-food processing is a major component. Research on agro-food processing is concentrated in the Department of Food Science and Technology (DFST), which is one of the six departments in the College of Agricultural Management, Rural Development and Consumer Studies (COLAMRUCS).

The Department of Science and Technology was actually established in 1983 as one of the foundation programmes of the then Federal University of Technology, Abeokuta (FUTAB). After the abrupt termination of the second republic by a military coup in December 1983, the restructuring of the new universities resulted in the merger of FUTAB with the University of Lagos. FUTAB then became a College of Science and Technology in the University of Lagos. When UNAAB was established in 1988, DFST became one of the foundation departments, which survived the various transitions prior to the establishment of the University of Agriculture, Abeokuta.

Active research in post-harvest technologies and food processing started at the inception of the department. The results emanating from such research in the past also had appeared in different learned and professional journals in various forms over the years. Several identifiable research units/groups, reflecting the different specialization and interests of the academic staff of the department, had emerged and many of them are in the forefront of the research in the University. The research units can be broadly classified as:

- Tuber crop utilization research unit
- Composite flour technology research unit
- Design and fabrication research unit
- Legume processing research unit
- Food quality and assurance research unit
- Microbiology and biology research unit

Some of these research units have become multi-disciplinary in nature and have attracted international funding and interactions.

It was however reported that the research initiation in the DFST has so far been largely from the perspective of the researchers, either as individual research projects, student-lecturer research projects, or collaborative research among a group of scientists within UNAAB. Funding could be from the researchers' private resources because of the motive of getting publications which are required for promotion or government research funding. In isolated cases, Non-Governmental organizations and foreign agencies may

be involved in funding research, while industries are rarely involved in research funding. Hence, most of the DFST research results that could benefit food industries remain on the shelf and are yet to be commercialized. The challenges have largely been how to bridge the gap between the University and industry to the benefit of both parties, and for the building of local technological capability required for economic development.

The foregoing notwithstanding, UNAAB has made some important contributions to research in agro-food processing in Nigeria. This is evident from the following list of specific research results in the DFST, presented in Table 3.

Table 3. Research outputs of the DFST

Research unit	Research projects	Commercialized?	UIL case?
1. Tuber crop utilization	- Fufu processing	Yes	No
	- Cassava: Adding Value for Africa (CAVA)	No	No
	- Sweet potato utilization	No	No
	- Yam processing and utilization	No	No
2. Composite flour technology	- Utilization of non-wheat flours in bakery products	No	No
3. Design and fabrication	- Cassava flash drier project	Yes	Yes
	- Multipurpose fruit juice extractor	No	No
4. Legume processing	- Processing and utilization of Nigerian legumes	No	No
5. Food quality and assurance	- Quality assessment of indigenous snacks such as, "robo", "kulikuli", "aadun"	No	No
6. Micro-biology and biology	- Fermentation technology of fufu, "iru" and other indigenous food products	No	No
	- Enzyme technology and Aflatoxin detection	No	No

Source: Fieldwork data

As reported by Oyewole (2008), other yet to be commercialized research outputs of the university, some of which are not domiciled in the DFST, include:

i) **UNAAB Alpha Broilers:** These are Trihybrid broiler strains, AGB and AGN adapted to the climatic management conditions prevalent in the tropics with much tastier meat. They were created by improving the Nigerian indigenous chicken (N) using exotic chicken strains; Anaktitan (A), Giriraja (G) and Alpha (B) indigenous chickens. These birds are profitable, easily managed and adapted to backyard farming for African homes.

ii) **Maize Cob-based Microbiological Growth Medium:** Cobs from maize (*Zea mays*) were used as raw materials to prepare growth media for moulds (*Rhizopus nigricans*, *Aspergillus tenuis*, *Fusarium sp.*, *Penicillium sp.*, *Debaryomyces sp.*). This demonstrated that cobs of maize, which are common waste material, could be processed as growth media for fungi to replace the expensive imported PDA and SDA.

iii) **Locally Sourced Passion Fruit:** In UNAAB, passion fruit (*Passiflora edulis* var. *edulis*), which is an exotic fruit from Brazil, has been adapted for cultivation in the Nigerian environment. The fruit is important for its medicinal properties and food uses

(juices, jams, jelly, ice cream flavours, herbal tea, oils, flavourant, juices and concentrates).

iv) **Development of a Programmable Scare Crow System:** Scientists at UNAAB have developed a programmable scare crow system for scaring away birds from farmlands. The system employs a simple physical control method based on the effect of a combination of a mechanical fixed-based robot as a visual device with an audible/ultrasonic DC based electronic sound system as an audible device to give long lasting birds and animals control in rice and fish farming. Four different types of the sound waves were generated at different frequencies. The generated sound waves, transmitted through four professional horn speakers and tweeters, were able to scare birds and animals effectively within a radius of 400 meters.

v) **Design and Construction of a 2.5Kw Solar Powered Generator:** The incessant power outages in the country called for alternatives that are more reliable and environmental friendly. Towards solving this problem, a renewable energy source, using solar energy, was developed in UNAAB.

vi) **Design and Development of a Vegetable Oil Filter Press:** A vegetable oil filter press for clarifying mechanically expressed oil from oil-bearing seeds - such as, beniseeds, groundnuts, melon and palm kernels - were designed and developed. The design output of the press is 80litres of raw oil per hour.

vii) **The Organic Agriculture System:** UNAAB is leading efforts through strategic interdisciplinary research in the diverse ecologies of Nigeria, leading to the development of commercializable, farmer adoptable, cost effective and sustainable organic agriculture production systems.

viii) **UNAAB Textiles and Woodcraft:** As part of efforts aimed at promoting local textiles, for which Abeokuta is known, the University of Agriculture, Abeokuta, is actively involved in using plant extracted dyes on local fabrics, coupled with exquisite hand-printed patterns that portray African culture in the production of unique UNAAB textile brands. The colours are fast and retain their catchy look throughout the life of the garments made. Various aspects of contemporary African culture are etched on wood panels. Both the textiles and the carvings are of export quality.

ix) **UNAAB 'Fufu':** UNAAB fufu is an 'odourless' food product from fermented cassava. The university, through its various research activities, has been able to overcome the disdainful peculiar odour of the traditional processing technologies and has developed a dry product with longer shelf life. It is neatly packaged in various sizes for convenience. It is easy to prepare, and is a potential housewife's delight.

x) **Medicinal Plant Products:** Scientists in the university have been able to develop various medicinal products from plant materials. These include various formulations for the treatment of athlete's foot, high blood pressure, sore throat, heart attack, varicose veins and muscular pains, obesity, epilepsy, edema, high cholesterol, whooping cough, common cold, vomiting cough, asthma, diarrhea and rheumatism.

xi) **Charcoalated Coconut Shell:** Coconut shell is normally considered a waste product. However, coconut shell can be charcoalated and pulverized, and the powder used as a detoxifier, fertilizer and in far infra-red baths. UNAAB has perfected the

technology for charcoalation of coconut shell for import substitution and generation of value added products.

xii) UNAAB Twin Bee Hive: Scientists in UNAAB have been able to develop a unique twin bee hive from seasoned wood, which has great advantage of space maximization. The UNAAB bee hive offers opportunity for bees' activities in one compartment, storage of honey in the other and with low bee casualty during honey harvesting.

xlii) UNAAB Nutrient-Based Traditional Product: Scientists in UNAAB have been able to develop legume-based, iron-fortified and beta-carotene traditional products from cassava, yam and plantain, which has great advantage for reducing the micronutrient deficiencies prevalent in many developing countries.

One very important UIL project, which started as a research project but presently has no research component, is the UNAAB-Nestle soyabean popularization and production project which started in 1999. As a UIL case, it would be examined in detail in the next subsection. Similarly, as shown in Table 3, the cassava flash dryer project was identified as a UIL project and it will also be examined in detail in the next subsection.

UIL CASES

Among several research activities in agro-food processing identified, only two can be categorized as cases of university-industry linkage. These are:

- i) UNAAB-Nestle Soyabean popularization and production project; and
- ii) Cassava flash dryer project

UNAAB-Nestle soyabean popularization and production project

Nestle Nigeria PLC has been the only major external donor and industrial partner with UNAAB.⁷ Nestle-UNAAB collaboration has been on the popularization of soyabean. The main objective of the project is to stimulate sustainable interest of farmers in soybean production, with a view to increasing their capacity to produce seeds of industrial quality and consequently, their socio-economic status. According to AMREC (2007), the specific objectives of the project include:

- i) Ensure that the soyabean becomes acceptable and properly integrated into the existing farming systems in the southwestern part of Nigeria.
- ii) Ensure massive production of high quality grains that would meet the needs and quality standards required by Nestle Nig. PLC on a continuous basis.
- iii) Improve the welfare of the farmers through the income that could be generated from soybean production.

It is a farmer oriented project, essentially aimed at making farmers grow more soyabean that is of industrial quality.⁸ The collaboration started about 10 years ago. Although the

⁷ As an indication of the level of Nestle support for the project, it was reported by AMREC (2007) that Nestle provided a grant of N5 million for the project in 2007.

⁸ The Nestle-UNAAB project started with a pilot scheme in the 1999/2000 planting season in two model extension villages (Ilewu Orite and Ijale Papa in Abeokuta North Local Government Area of Ogun State). All operations at the pilot stage were funded by Nestle. In the 2001/2002 planting season, another extension village (Maya in Ibarapa East Local Government Area of Oyo State) was added to the pilot scheme. This extension village demonstration gave rise to a rapid diffusion of the soyabean cultivation in the Southwest. Farmers in the neighbouring villages (e.g. Lanlate,

collaboration can be traced to initial UNAAB-Nestle research in crop production, there is currently no research component of the collaboration. This is obvious because the research component was completed before the Nestle-UNAAB soyabean popularization project started. The research that preceded the project was carried out by the current Deputy Vice Chancellor (Development). The preceding research used Nestle facilities and addressed issues such as, acceptability to the farmers and end user (Nestle), nematode tolerance, no shattering of pods before harvesting, etc. However, the RESDEC is prepared to revive the research component of the collaboration if there are crises or challenges in the field, such as, drop in the yield potential, disease outbreak, and pods shattering before the seed ripens, or need to develop soya variety that satisfy new industrial requirements. RESDEC would then be responsible for raising research teams that would address the challenge and proffer solutions. As long as the current project regime satisfies Nestle's seed quality requirements and farmers get satisfactory price⁹ for their outputs, there may be no significant research component in the project. There is no problem on the field with respect to the project, and therefore RESDEC is focused on other research challenges. To provide a deep insight into the initial research component of the collaboration, Box 7 below presents the findings of the interview with the Deputy Vice Chancellor (Development).

The UNAAB-Nestle project supplies the seed, herbicides, land preparation (sometimes), and diesel powered thresher to farmers. With the exception of the thresher, these items are supplied on credit without interest. The thresher is expensive (costs N300,000/unit) and thus its supply is free, but limited to one thresher per state per annum.¹⁰ The supply of the thresher started in 2004. The farm locations are far from each other and it is expected that each farm would have a thresher supplied by the project in the course of time. Threshing is the most difficult aspect of soyabean production. The threshing operation removes the pods, shafts, stones and other debris from the grains. The threshers are locally fabricated at the IAR&T, and the economic life of the thresher is specified as 10 years. The supply is limited to only one per state per annum because the resources available cannot cope with supplying the large number of farmers involved in the Nestle-UNAAB project.

Eruwa, etc.) observed the success of the project in Maya, and thereafter proceeded to adopt the soyabean variety for cultivation. The farmers obtained the seeds by themselves from IAR&T and subsequently from Oyo State ADP. They thereafter requested Nestle to buy their harvest under the Nestle-UNAAB project. Subsequently, Oyo ADP promoted the planting of the soyabean by the farmers while AMREC ensures that Nestle buys the harvest. Oyo State farmers now plant a minimum of 100 hectares annually.

⁹ The price at which Nestle buys the soyabean is fixed by its headquarters in Switzerland. The local subsidiary has no control on this. Farmers occasionally sell to alternative markets if the price offered by Nestle is not good enough.

¹⁰ States involved in the project includes Ogun, Oyo, Lagos, Osun, Ekiti and Ondo. The project now has 600 farmers located in five states. Ondo has not been involved in the project since 2007 to date. This arose because another firm contracted Ondo farmers to plant the soyabean in 2007 before the project could provide adequate information on the Nestle price for the harvest. Nestle currently buys at N74,000/ton. Besides, it was becoming difficult for the project's resources to cover Ondo State due to its distance from UNAAB.

Box 7. Initial research component of the UNAAB-Nestle soyabean project

- In 1992/93 Nestle Nigeria PLC, under the managing directorship of an Abeokuta Chief, thought UNAAB could help solve the problem of local sourcing of raw material such as, soyabean, sorghum, maize and onions. Research collaboration between UNAAB and Nestle was initiated, and this boosted the interest of the Deputy Vice Chancellor (DVC) in soyabean research. The DVC had earlier carried out some preliminary study on soyabean in partnership with IITA. The DVC and his research team examined the prospects of each of the main raw materials suggested by Nestle and concluded that maize was not challenging because anybody could grow maize; his research team had no complementary personnel that could assist in breeding sorghum; and none of the research team members was interested in onions. With the DVC's previous experience in soyabean, the research team picked up interest in soyabean breeding.
- Nestle had a farm (ADN-Agro Development Nigeria Ltd) in Kaduna where soyabean and some other grains were cultivated. The DVC was appointed by Nestle as a consultant to the farm. The farm was importing seeds from Brazil. The main problem that the consultant was to address was how to increase output/yield and source seeds within Nigeria. He was the only breeder on ground and there was no way of investigating the breeding of other seeds apart from soyabean, which was the main interest of the consultant. Since the breeder was working in partnership with the IITA, a tripartite agreement was signed for soyabean breeding between UNAAB, IITA and Nestle. The Nestle farm paid for the consultancy and financed the soyabean breeding project. The aim of the project was to obtain soyabean of high quality that suits Nestle's requirement and also produces significantly improved yield. The research team achieved this objective with the breeding of soya 1448-2E. The seed was taken from the lines at the IITA trial farm to ADN Ltd, Kaduna for Nestle's farm managers to select seeds that they consider best suitable for planting. Nestle farm managers in Kaduna were actively involved in the lines selection during the trials in Kaduna and there was exchange of knowledge between them and the research team. The research team and the farm managers agreed on the mode of cultivation (quantity of fertilizer, herbicides, etc.). However, the farm project thereafter failed apparently due to poor management. Some bad management practices set in such that the cost of producing the seeds became too expensive. Nestle discovered that it was cheaper to import soyabean than growing it in Nigeria. The farm was consequently sold to a prominent Nigerian family by 1996. The initial agreement between UNAAB/IITA/Nestle thus ended. However, Nestle still holds the research team, which consulted for the ADN, in high esteem. For about two to three years, there was no relationship between UNAAB and Nestle. At about 1999, Nestle came back to ask UNAAB if there could be other ways of being of help to Nestle. UNAAB told Nestle that the previous research collaboration had established that soyabean can also be grown in Southwest Nigeria. So UNAAB started a project with Nestle on the popularization of soyabean in Southwest Nigeria. Nestle had previously

¹¹ A major concern in soyabean production is for farmers to harvest at the right time. Delay of harvest may lead to harvest spoilage by rainfall. When rain falls on the ripe grains, the grains become moist and begin to germinate. There is also discolouration of the seed, which makes it unsuitable for high quality baby food or increases the cost of production of the baby food. When the germinated seeds dry, they become sterile and thus non-viable as seeds for planting.

been made to believe that soyabean can only be grown in Northern Nigeria. It is thought that rain must not meet the soyabean harvest in the field.¹¹ Although this is true, it had been demonstrated that wholesome harvest of soyabean could be obtained in spite of the rains in the Southwest.

Nestle Nigeria PLC employs about 1800 people and soyabean is a major raw material used by Nestle especially for baby foods. Interviews with the Nestle official in charge of the UNAAB-Nestle project, confirmed the key findings from data collected from the university. From the perspective of the firm, the reasons for the UIL were presented as follows:

- to make available high quality and improved grains for Nestle;
- to protect the interest of farmers on whom Nestle depends for soyabean. Nestle pays competitive prices for the soyabean, usually with a margin above what the farmers can get from the market;
- to provide post harvest technology that can enhance farmers output. For example, Nestle has provided six threshers for the soyabean farmers under the collaboration project; and
- to promote rural development and employment as a corporate social responsibility.

Nestle believes that the UNAAB-Nestle collaboration is still evolving and may include research collaboration in future. Box 8 presents the constraints on UIL in Nigeria, as perceived by Nestle; while Box 9 contains the constraints on UIL, as expressed by the DVC.

Box 8. Constraints on UIL in Nigeria from firm interview

- The university structure and curricula in Nigeria are generally outdated and thus need to be overhauled. This affects the recruitment of Nigerian trained personnel. Nestle has to retrain graduates of Nigerian universities. The university curricula should be regularly updated in terms of quality, relevance, diversity and appropriateness for industry. The skill needs of industry are constantly changing and universities should learn to adapt to the changes by making the curriculum dynamic. The Nigerian universities are not current.
- The government is not serious about encouraging industry and research. The research infrastructure is poor in the universities. Industry can be helpful only when government provides incentives for industry to do so. There is enormous tax burden on industry from Federal, State and Local Governments. In spite of the tax paid by firms, there has been virtually nothing given in return to industry. For example, the access road and roads within the Agbara Industrial Estate (where the Nestle factory is located) are very bad. The investment climate in Nigeria is generally bad for industry, and this makes it difficult to invest in collaborative research with universities. In fact, the research of Nestle in West Africa was relocated out of Nigeria a few years ago because of the poor investment climate. The situation has not improved significantly.

Box 9. Constraints on UIL from the perspective the DVC

- The managing director was a major influence in convincing Nestle to start the initial collaboration with UNAAB. Research component of UNAAB-Nestle collaboration is presently nonexistent because Nestle is unwilling to support further research. There is international politics in soyabean production. Even IITA has stopped research on soyabean because of the USA. The USA provided money for soyabean research in IITA, but the USA now believes they can produce soyabean for the whole world. The USA is no longer supporting research on soyabean in developing countries.
- The main constraints on university-industry collaboration: Multinational companies (MNCs) prefer to spend money on research in their home countries. This is unlike in developed countries where industries go to universities to carry out research that address company's problems. MNCs believe in supporting research in their home countries. There is international politics involved. MNCs will not support research in the host country. There is a lack of confidence from industry, and industry believes that Nigerian universities will not do things according to their own ways. UNAAB has asked some firms what it can do for them but the firms are not forthcoming, no definite response has been received as yet. The leadership problem in the country: our leaders do not know what development is, they spend money elsewhere but not on research. Money goes into the wrong places.

Cassava flash dryer project

The principle of flash drying is well known in engineering theory and practice. Flash dryers are applied for rapid drying. The flash dryer is currently the best dryer for cassava starch, and it dries the cassava mash in 2 seconds. There is hardly any noticeable contact with the dryer, except when loading, and this ensures the avoidance of contamination. However, the principle of flash drying has not been applied in the design of engineering equipment that is used in the processing of indigenous agricultural crops. The researchers interviewed claimed that this design gap is perhaps due to the fact that the engineering properties of most of the Nigerian crops are yet to be determined. The flash dryers available in the market are designed for agricultural products that are grown in industrialized countries that manufacture flash dryers. For example, flash dryers commonly used in Nigeria, are those originally designed for drying Irish potatoes or maize. It is usually modified, with the help of foreign technical partners, for use in cassava processing.

Cassava is Africa's second most important food staple, after maize, in terms of calories consumed, and it is widely acknowledged as a crop that holds a great promise for addressing the challenges of food security and poverty reduction (Nweke et al, 2001). The cassava production status in Nigeria, between 2000 and 2003, was put at 39 million tons. The Presidential Initiative on Cassava Production and Export (PICPE) was set up in 2002 and was officially launched in 2004. The National Sensitization Programme on PICPE, conducted by the Office of the Special Assistant to the President on Food Security in 2004/2005, provided new impetus for increased cassava production. Nigeria is currently the world largest producer of cassava.¹² The production level in 2006 was

¹² The growth in cassava production has been primarily due to rapid population growth, large internal market, availability of high yielding improved varieties of cassava, and the existence of improved processing technology (Nweke et al, 2001).

estimated to be 49 million tons of cassava tubers, and about 75% of the production is consumed in the form of food (CBN, 2007; Adeniji, 2007).

Under PICPE, the government promotes the diversification of the economy through industrial processing of cassava to add value and achieve significant export of cassava products. Support for research on cassava processing and cassava products was a major aspect of PICPE. PICPE brought together cassava stakeholders¹³ to address the challenge of cassava production and industrial processing, which included the design and fabrication of the cassava flash dryer. UNAAB became involved in the project through a senior lecturer, who was at the IITA for his sabbatical leave when the research project started. He became one of the important researchers on the project and the flash dryer project was recognized as one of the main research projects in the Department of Food Science and Technology, UNAAB. UNAAB subsequently extended his sabbatical leave for one year, and thereafter he continued the research collaboration after his return. His experience and research linkages had also attracted further internationally sponsored research into the university.¹⁴

The flash dryer project is a combination of original design and reverse engineering. Flash dryer development (modification of the first commercial flash dryer plant) has been conducted since 2004; and the research team got the efficient and working plant in 2007. As mentioned earlier, the principles of flash drying are well known and there are many flash dryers in the market. However, the locally fabricated flash dryers are generally not designed and their efficiency is very low.¹⁵ Attempts to adapt foreign flash dryers have resulted in considerably low performance and frequent equipment breakdowns. This was the experience of Godilogo Farms Ltd, a privately owned large integrated farm having extensive cassava plantation and a cassava processing factory, that had used a flash dryer imported from Brazil. The farm's cassava plantation could supply its cassava processing factory 250 days of cassava inputs. The farm also has an engineering workshop or firm for equipment maintenance and components fabrication. The frustration of Godilogo Farm, with the imported flash dryer, was the motivation of the farm's management decision to support the cassava flash dryer project. After the farm management was convinced that the flash dryer research team constituted under the PICPE cassava processing research, had a feasible design, Godilogo Farm made available its engineering facilities and funds for the fabrication of the cassava flash dryer *in situ* at the farm's cassava processing factory. Box 10 provides the chronology of cassava flash dryer development and UNAAB's involvement; while Box 11 presents the constraints on UIL as perceived by the flash dryer researcher.

¹³ Notable among these stakeholders are the International Institute of Tropical Agriculture (IITA), Raw Material Research and Development Council (RMRDC), Federal Institute of Industrial Research (FIRO), Edo State Agricultural Development Programme (ADP), and Godilogo Farms Ltd.

¹⁴ For example, the researcher brought to UNAAB, the 'Cassava: Adding Value for Africa (CAVA)' project funded by the Gates Foundation through the NRI. The project had a grant of US\$90,000 in 2007; and currently US\$170,000 in 2008. The project is directly managed by him and will run for five years from 2007 to 2011. The project has five countries which include Nigeria, Ghana, Tanzania, Malawi and Uganda. UNAAB has credibility in using the research project fund. The university takes only 10% of the fund for administration and bank charges.

¹⁵ Imported flash dryers are expensive, with the cheapest costing about N3 million and can dry at least 5 tons of cassava per day. Besides the likelihood of technical problems in operation, cassava processing is largely done in cottage or small scale industries which can not afford the financial overlay of an imported flash dryer.

Box 10. Chronology of cassava flash dryer development and UNAAB's involvement

- The UNAAB food scientist had instant fufu¹⁶ flour as his PhD output in 1999.¹⁷ The PhD was obtained from the University of Ibadan though the bench work (sponsored by a World Bank Fellowship) was done at the Natural Resources Institute (NRI), UK.
- The PhD project was funded by the World Bank fellowship and IFS grant. It also benefited from grants to the UNAAB by the DFID and EU. The outcome of the PhD project led to his participation in an integrated cassava processing project at the IITA, Ibadan, when he was on sabbatical leave with IITA (between 2004-2006).
- Cassava products are dried by sun drying and solar drying of cassava mash in rural areas. Following changing habits of consumers and the current wave of urbanization, new dryers have been developed in Nigeria (rotary and flash dryers, by some fabricators like ADDIS Engineering, Starron, Lagos and Peak Products, Abeokuta). The University of Agriculture, Abeokuta, in collaboration with the Natural Resources Institute, Chatham Maritime, Kent, and the UK, used the rotary dryer at pilot level to commercialize the instant fufu flour in 2001. The instant fufu flour has also been produced by other small scale firms for the last five years in Nigeria.
- The launch of PICPE and the commencement of the Integrated Cassava project of IITA in 2004, spurred on the development of a diesel-operated rotary dryer (300 kg/8h) and a new version of the locally fabricated flash dryer with a product contact surface made of stainless steel. It was also observed that equipment such as flash dryers that can be used to process flour, starch, etc., was gaining more patronage by processors in Southwest Nigeria (mostly in Ogun State where UNAAB is located and a few in Ondo State).
- The cassava processing project at the IITA included the fufu flour technology. The IITA project was funded by the Federal Government's PICPE, NDDC, USAID, and SPDC (Shell). The fufu flour technology involved the installations of rotary and flash dryers in SME factories in some NDDC states (Rivers, Akwa Ibom, Cross rivers, Delta, Ondo, Ime, Anambra, Ebonyi, Enugu, Abia, Edo, and Bayelsa).
- Flash dryer development became necessary in 2006 because of the need to improve the production efficiency, fuel use and robustness of the fufu flour technology. IITA assembled a team of Engineers (IITA, RMRDC, UNIPORT, SEDI, UI, FIIRO, Edo ADP and UNAAB) to understudy existing dryers and come up with a more efficient flash dryer design. Based on the preliminary report, RTEP under IFAD, RMRDC and Godilogo Farms Ltd bought into the flash dryer modification. A privately owned engineering firm, Peak Products Ltd Abeokuta was involved in the research as an equipment fabricator. The new working plant can produce 250 kg of cassava flour per hour. RMRDC funded the official commissioning of the new flash dryer at Godilogo Farms, Obudu, Cross Rivers State, on 19 August 2008. IITA provided initial funding; RTEP provided a Design Team visit to collect more data from existing flash drying

¹⁶ Fufu is a local food staple originally produced manually through an elaborate wet process. The instant fufu flour is a major improvement on the traditional wet process.

¹⁷ The researcher could not present this output for patent because other similar initiatives existed before his research work. FIIRO for instance had produced so many dried products including fufu flour using FIIRO industrial pilot plant which was installed in the late 1960s. Besides, there are a few SME factories like Top Rank Factory in Ile-Ife producing fufu flour. His research harmonized all drying options both in Nigeria and UK with appreciation of chemical responsible for fufu's offensive odour especially for wet fufu. Obtaining consumer acceptable fufu flour was his major achievement, and this speeded up the diffusion of the technology among SMEs in Nigeria.

centres; Godilogo paid for the fabrication of the plant and part sponsorship of researchers' living costs; and RMRDC provided logistic supports for several trips by the Design team including sponsorship of the commissioning.

Box 11. Constraints on UILs as perceived by the flash dryer researcher

- Lack of understanding of roles by researchers and industry.
- The entrepreneurship culture in Nigeria does not support research.
- Lack of incentives or government support for firms' R&D.
- Mistrust of researchers because some firms have unproven allegation that researchers in some universities failed to deliver the expected research results.
- Inconsistency and lack of implementation of government policies: no policy to compel industry to do research locally. There is need to compel firms to do at least 10% of research locally. Nigeria has competent researchers that can be sourced for this local content of industry's R&D.
- Credibility issues that include lack of accounting systems that satisfy international best practice, and possibly, lack of competent researchers.
- Money voted for research, by government, is not getting to universities.
- Lack of research equipment. For example, no pilot plant exists at UNAAB as in the University of Reading in the UK. SMEs cannot grow or upgrade technology without access to demonstration pilot plants in the universities.

Biotechnology and UILs

It is pertinent to note that there has been no significant role for biotechnology in the two UIL cases identified at UNAAB. For the fufu technology, it was observed that biotechnology could play an important role because it is a process of submerged fermentation. It could be expedited with starter cultures instead of back-slopping which most people presently use.

Furthermore, a professor of microbiology, who has worked extensively on the production and use of amylase enzymes, provided an overview of his experiences to illustrate the constraints on UILs in Nigeria. The summary of his narration is presented in Box 12. He worked on microbial enzymes because a lot of food processing firms in Nigeria use enzymes. He claimed that N12 billion worth of enzymes are imported annually into Nigeria in recent years. He specifically started research on enzymes 10 years ago to tackle the problem of local production of enzymes for food processing. In carrying out the research in phases and after 10 years of research, he has now been able to produce amylase enzyme in the laboratory. He has also demonstrated that it can be produced in commercial quantities if entrepreneurs are ready to invest in it. The Amylase enzyme is used for starch processing (e.g. cassava). For example, cassava starch cannot be processed into glucose or alcohol without the amylase enzyme. An aspect of biotechnology is applied in the process of getting a better yield of a certain strain of the amylase enzyme.

Box 12. Constraints on UIL: the case of amylase enzyme technology

- Constraints on university-industry collaboration: Nigerians have no faith in themselves; poor laboratory infrastructure; trained in Australia and got PhD in the early 1990s with no significant support from the Nigerian government; no local source of funding; RMRDC has not been helpful; no support from abroad because developed countries would not support research that would increase development; electric power problem; no R&D unit of Multinational Companies (MNCs) in Nigeria; and the MNC has only small labs at best, where tests are done to ensure that processes and products conform to the specifications of the parent company; local firms have financial problems and thus cannot finance R&D.
- Patented IMARSIL in 2002 in Nigeria. IMARSIL is a process used to concentrate the enzyme. IMARSIL has not been patented in the USA because of funding constraints, US\$5,000 is required to patent it in the USA.
- Government policy does not enforce, by law, that MNCs carry out R&D in Nigeria; corruption is also a problem, it must be tackled if university-industry collaboration should be promoted – some regulators/government officials compromise the law because they receive favour from MNCs. There should be political will to address the university-industry collaboration.
- To address the frustration of lack of support, professors plan to start their own commercial production of amylase in his private capacity.

CASE STUDY 2: FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE

UNIVERSITY VISION AND MISSION

The Federal University of Technology, Akure (FUTA), is one of the specialized universities created by the second republic civilian administration in December 1981 - in accordance with the National Policy on Education which aimed at promoting technical and scientific training at every level of the educational system. Six other universities of technology were founded at about the same time.¹⁸ Four of the seven universities of technology were merged with older universities in a university re-structuring exercise carried out by the Federal Military Government in June 1984. However, FUTA was one of the three universities that survived this merger. The location of these universities was largely influenced by geo-political considerations, consequent upon which only FUTA was located in southwest Nigeria¹⁹.

¹⁸ The states of the Federation, which had no Federal University, became the immediate beneficiary of the new government policy. The seven states involved included Bauchi, Benue, Gongola, Imo, Niger, Ogun and Ondo. Three universities of technology were founded in Bauchi, Benue and Imo in 1980, while the other four were established in 1981 (FUTA, 2005).

¹⁹ Prior to this time most of the universities in Nigeria were located in southern Nigeria, especially the southwest. Out of the initial seven Federal Universities of Technology, only two were located in southern Nigeria: Owerri, Imo State in the southeast and Akure, Ondo State in the southwest.

The notion of technology as a tool for self-reliance captioned as "technology for self-reliance", form the motto of the university or the guiding principle of its service delivery. The university's vision and mission statement are as follows:

Vision statement:

The Federal University of Technology, Akure, aims to be one of the best Universities of Technology in the world, committed to carrying out an enviable niche for itself as a centre of excellence, epitomized by high quality programmes, products and contributions to the society.

Mission statement:

The Federal University of Technology, Akure (FUTA), will ceaselessly promote technological advancement through motivated and skilled staff dedicated to teaching and research, geared towards global needs and production of self-reliant high level manpower, goods and services.

The primary objectives of FUTA, like any of the other universities of technology, are to:

- develop and offer academic and professional programmes leading to the production of graduates and higher degrees, which emphasize planning, adaptive, technical, maintenance, development and palliative skills in engineering, scientific, agricultural, environmental, management, medical and allied professional disciplines;
- act as an agent and catalyst through postgraduate research and learning for most efficient, effective and economic utilization, and exploitation and conservation of the country's national, economic and human resources.
- offer to the general public, the results of research and foster the applications of these results;
- identify technological problems and needs of the society relevant to the immediate localities of the university, and solve them within the context of the national needs; and
- provide and promote sound basic scientific training reflecting indigenous culture and enhancing national unity while at the same time ensuring the production of socially matured citizens.

In pursuance of these objectives and in recognition of the need for an interdisciplinary approach to the solution of the most practical problems and the application of science and technology to the development, FUTA has adopted the school (as opposed to the faculty) as the basic unit, thus endorsing the concept of a school as a fully integrated unit of a group of related subjects or disciplines which have a common academic interest in teaching and research. All degree programmes are of five year duration and every student must have at least a semester of relevant industrial experience to qualify for the award of a degree (FUTA, 2005). From the interviews conducted with the university officials, it was stressed that the Student Industrial Work Experience Scheme (SIWES) serves an avenue for university-firm interaction only to the extent that industry receives the student for industrial exposure, but without any direct commitment to active interactions that involve significant knowledge exchange.

FUTA has five schools, which include the School of Agriculture and Agricultural Technology (SAAT), School of Engineering and Engineering Technology (SEET), School of Environmental Technology (SET), School of Science (SOS), and School of Earth and

Mineral Sciences (SEMS). Added to this, the university has a School of Postgraduate Studies (SPGS) responsible for the administration of higher degree programmes. The University currently has 300 academic staff, 1,300 non-academic staff, and a total enrolment of 2,620 students. Table 4 shows the distribution of the university population by gender.

Table 4. Distribution of FUTA staff and students by gender, 2008

Category	Males	Females	Total
Academic staff	205	95	300
Non-academic staff	800	500	1300
Students	1744	876	2620
Total	2749	1471	4220

Source: Field Survey, 2008

INSTITUTIONAL CONDITIONS AND STRUCTURE FOR RESEARCH

According to FUTA (2005), FUTA has a university research grant committee which has three main functions:

- advise the university senate on the development of research in the university and coordinate all research activities in the university, whether funded by the university or outside grants;
- authorize applications for grants for research after they had been considered by the school research committee and before such applications are submitted to the granting agencies; and
- administer the university research grants, and such other funds, as placed at the disposal of the university for research and allocate funds at its discretion, after considering requests and recommendations from the school's research committee.

The university research grant committee administers the statutory allocation for research from the NUC. The level of funding is generally considered very poor and hence, success has been very limited with respect to research projects funded by the university research committee. Moreover, most of the research projects funded are not directly intended to foster university-firm collaboration because they are largely concerned with research for the sake of knowledge generation and academic advancement, rather than knowledge for development. The researchers in each academic department have the right to decide on their own research topics, and the department could only facilitate the administrative procedures. The department has no provision for funding individual research projects. The centrally available grants are given to each school to give to well written proposals, but because this allocation meant for research is so small, it therefore involves tough competition among researchers and groups of researchers.

Within the university structure there are two important agencies responsible for R&D functions aimed at promoting university-firm interactions. These agencies are:

- Center for Research and Development (CERAD); and
- Business Development Company (BDC).

Each of these two agencies is headed by a director, who is directly accountable to the Vice Chancellor of the university.

Center for Research and Development (CERAD)

The Center for Research and Development (CERAD) was established by FUTA in 2003 as a non-profit organization limited by guarantee with three main objectives:²⁰

- to identify technological problems and needs of society and solve them through research;
- to provide the much needed impetus for rapid technological and industrial development in Nigeria; and
- to serve as a linkage mechanism between university and industry.

The establishment of CERAD arose out of a growing concern for FUTA to make a significant contribution to arresting the decline of Nigeria's industry by creating a mechanism for university-industry collaboration. CERAD aims at laying the results of R&D efforts of the university at the doorsteps of industry in order to stimulate the application of research results for the benefit of society. It seeks to bring the university and industry together in their operations with neither losing its core values, but with each engaging in a win-win partnership.

As presented in CERAD (2003), the vision and mission of CERAD are stated as follows:

Vision statement:

"to be the leading Research and Development Centre in Nigeria and to become a Model Industry-University Linkage outfit for actualizing the town-and-gown concept in the Nigerian university system."

Mission statement:

"to identify the technological problems and needs of society and seek to solve them through focused research"

CERAD is presently structured into eight research groups with each group led by highly experienced and competent research scientists. The eight research and development groups include the following:

- Environmental Management Research Group
- Enterprises Development Research Group
- Agricultural Resources Research Group
- Bitumen, Oil and Gas Research Group
- Solid Minerals and Natural Resources Group
- Operations Research Group
- Engineering Research Group
- Information and Communication Technology Research Group

Moreover, CERAD receives and manages endowments by philanthropists for the purpose of research and development. According to the director of the centre, the following sources of research funding are currently available at CERAD:

- Ayo Ajayi Fellowship in Food Storage and Preservation - purposely to promote research and scholarship in the technology of food storage and preservation.
- Mala Kachalla Research Grant in General Agriculture - to enable capable Nigerians to contribute fully to food security through research and scholarship.

²⁰ See CERAD (2007) for more detailed information on the corporate profile and functions of CERAD.

- CERAD Research Grant - is made available purposely to enhance applied research in Nigeria with funding derived exclusively from the internally generated revenues of the centre.

The team of our researchers held an interactive session with the director of CERAD. Box 13 presents the key information obtained from the interactive session.

Box 13. FUTA's Interactions with firms as perceived by the Director of CERAD

- Although CERAD is relatively young, it has gradually established itself in achieving its objectives largely through consultancy projects.
- To promote commercialization of the university's research outputs, a unit has been established within CERAD to work on intellectual property right issues such that patents could be obtained for research outputs that have commercialization potential.
- Some of the industry-relevant research activities are anchored by CERAD, while other research activities are based in academic departments where individual researchers or groups of researchers administer research projects.
- Scientists from the academic departments are enlisted by CERAD to implement research activities and they are paid honoraria that are determined by the terms of the contract with the industry involved.
- Although partnerships and relationships have been established between CERAD and some firms, industry typically has an arms length relationship with CERAD. Firms have keen interest only in the project deliverables. Some of the projects are based on informal linkages with former students. The linkages that individual researchers have with firms are also largely based on informal linkages or personal recognitions through professional associations and former students.
- Some of the notable CERAD agro-food projects that have linked FUTA with industry include:
 - Product development in food processing for United African Company (UAC) PLC, Jos, Plateau State.
 - Product analysis on starch production for MATNA Food Ltd, Ogbese, Ondo State.
 - Consultancy services on cocoa production for Olam Cocoa Industry Ltd, Akure, Ondo State.
 - Consultancy services on food processing for Sunrise Cassava Processing Factory, Ondo, Ondo State.
 - Consultancy and technology transfer on animal feeds for JOFA Ltd, Akure, Ondo State.

Source: Field interview

The Business Development Company (BDC)

While CERAD was established mainly to engage in research and development activities, the Business Development Company (BDC) was founded in 2002 as an offshoot of FUTA Ventures Ltd. The BDC is conceived, essentially, as a mechanism for project delivery in almost any endeavour that can contribute to the university's internally generated revenue.²¹ The main objectives of the BDC are to:

- identify all projects that can promote resource flow into the university and implement them profitably;
- provide sources of additional income for department, units and staff participating in its activities;
- adequately project the university as an institution providing a wide range of technical services to industries and the society at large;
- carry on business as contractors on Civil, Mechanical, Electrical and Agricultural Engineering within and outside the university;
- carry on business of dealers and suppliers of computers and its accessories, specialized scientific equipment for universities, research institutes, colleges of education, colleges of technology and hospitals;
- carry on the business of agricultural development in all its fields, including poultry and pig farming and animal feed production;
- market or offer for sale agricultural products which are produced as a result of research and manufacturing processes at the University (e.g. Animal Feeds Production, Food Processing, Fruits Juice and Allied Agricultural Products); and
- market to the public any scientific invention or any product of research developed work or experiments from the CERAD, or any of the schools in the University, either to individuals or corporate bodies or government parastatals.

RESEARCH IN AGRO-FOOD PROCESSING

The findings obtained through the interactions with key university officials indicate that CERAD and the Department of Food Science and Technology are the agencies that are directly involved in research in agro-food processing at FUTA. FUTA requested for the establishment of the Department of Food Science and Technology (DFST), from the National Universities Commission (NUC) in 1992. The NUC, however, approved its establishment as a programme in the School of Agriculture and Agricultural Technology. The University Board of Studies resolved to place the food science and technology programme in the Department of Crop Production, until it would be granted an autonomous status as a department. The guiding principle of the programme is to train technically skilled graduates capable of working in existing food industries, using locally available raw materials to set up cottage food processing industries (to reduce post harvest food losses) as well as make nutritious and wholesome food available to consumers. The first set of students (21 in number) was admitted during the 1993/94 academic session, and 17 of them finished the programme in 2000. After the successful graduation of the first batch of students and a NUC review of the study programme, the NUC approved the food science and technology programme as a full-fledged

²¹ According to FUTA (2005), FUTA Ventures Ltd. emerged in 1991 as a transformed FUTA Consult Ltd. FUTA Ventures Ltd was later re-structured (in 2002) and re-named FUTA Business Development Company.

department in July 2001. The DFST has since witnessed a tremendous growth in staff and number of students.

The DFST has the following objectives:

- To produce skilled technical and managerial manpower for agro-allied industries.
- To produce skilled manpower required to establish, manage and direct small-scale food processing and allied industries using available locally sourced raw materials in line with the institution's motto, 'technology for self reliance'.
- To produce graduates who will be involved in consultancy services in food product development, research and development, processing and preservation. This, no doubt, will reduce post harvest food losses and produce 'job creating' graduates rather than 'job seekers'.
- To produce graduates with the knowledge of design and fabrication of food processing equipment to assist in developing traditional technology.
- To produce graduates who will be able to teach food science and technology and allied courses in appropriate institutions of higher learning.

There is evidence that FUTA has engaged in various research and development (R&D) activities over the years, especially in the agro-food processing sector. From interviews and data obtained, the following projects were identified as the major agro-food research projects that were carried out by FUTA in recent years.

Post-harvest technology programme

The post-harvest technology programme was sponsored by the Union Bank of Nigeria Plc, which is one of the major banking institutions in Nigeria. The project involved a team of research scientists from different departments but was domiciled in the Department of Food Science and Technology (DFST). The project focused attention on the processing and storage of farm crops, with reference to grains and tuber, viz., maize, rice, cowpea, soyabeans, cassava, yams and cocoyams. As a result of this project, simple, cheap, and effective tools and machines for harvesting, processing and storage of farm crops were designed and fabricated.

Food storage is one of the most important issues in Nigerian agriculture, especially due to the problem of post-harvest losses. Estimates of annual post-harvest losses range from 20 – 25% for grains and grain legumes, and 30 – 50% and occasionally 100% in the perishables. These losses are enormous, resulting in the wastage of efforts in terms of money, materials, and labour impacting on land preparation for the planting and harvesting of crops and on the husbandry of animals. The support funding received from the Union Bank enabled the university to contribute to addressing the problem, and it is expected that some of the simple tools and agro-food processing equipment developed would be promoted especially for cottage industries. However, it is perceived by the university that government agricultural policy is still considerably weak and lack adequate incentives that can promote the adoption of the technologies developed through the post-harvest technology research programme. This notwithstanding, a series of workshops, conferences and seminars were organized by the university as a means of fulfilling part of the objectives of the research programme, which is to contribute immensely to the improvement of the technological development of the local farming system through extension services aimed at bringing the results of the research to the use and benefit of the local farmers. The participants at the research dissemination fora were made up of farmers (women and men), market women, food sellers, housewives,

health workers etc. The workshops provided the opportunity to demonstrate the construction of cribs using miniature cribs, and multi produce silo to all levels of users. The workshops created great awareness among the participants in realizing the importance of agro-food processing and storage, and the available solution to post-harvest problems. These were practical demonstrations of locally fabricated food processing and storage equipment, which attracted the participants with the hope that they will have access to the equipment.

Design and fabrication of solar dryer

The idea of fabricating a solar dryer was motivated by the desire to use simple equipment that traps the heat of the sun and at the same time encourages air movement by convection of heated air for drying agricultural products. This equipment is simple and cheap for small scale farmers to adopt, and materials that are readily available are used. It can also be up-scaled for use by large scale producers.

Design and fabrication of a de-stoning machine

The design and fabrication of a de-stoning machine for removing stones, debris and other materials from rice principally and sorghum, millet cowpeas and other important agricultural products, was embarked upon by the university's school of engineering. Grains constitute the most common simple food crops in Nigeria, and due to their dietary significance, several attempts have been made in the past to design a cleaning device for them. Most of the de-stoning machines that may be imported are very expensive and beyond the reach of local farmers and grain processors. The project therefore designed and fabricated a prototype de-stoning machine that is cheap, compact, versatile, and easy to operate and maintain. It is expected that the machine would satisfy the needs of local farmers and processors if its adoption is promoted.

Design and fabrication of a maize de-husking machine

The design and fabrication of a maize de-husking and shelling machine was also carried out by the school of engineering in order to fully mechanize the operations of de-husking and shelling maize. It was designed principally to remove the sheath of maize and at the same time shell and clean the grain. It has been fabricated and has undergone comprehensive testing to improve on its initial performance. The important components of the machine include the hopper, de-husking-shelling chamber, blower, suction fan, transmission units, an ejecting unit, cobs and trash outlets. The maintenance of the machine is cheap and easy. This had further improved the efficiency in terms of output, shelling percentage, cleaning, grain damage, grain loss and pavers consumption. It was used to shell more than ten tons of maize at a time, for the university farms.

Waxing effects on the physical and biochemical characteristics of oranges

This is an investigation into the effect of waxing on the physical and biochemical qualities of oranges stored in evaporated coolant structures. The effect of waxing on the physical and biochemical characteristics of navel and local sweet oranges stored in tin pot, pot in pot and native baskets at ambient condition over a period of ten weeks were studied to eliminate or reduce the losses during post harvest handling. From the study, waxed oranges had higher nutrients, better appearance and taste, and delayed ripening at the end of the storage period. These properties led to an increase in shelf life of the oranges. The pot in pot evaporative coolant structure was more efficient when compared

with the tin in pot evaporative coolant structure, as it was able to reduce the temperature by an average of 10°C and thus reduce metabolic activities in the stored oranges.

The cost of wax production, applying wax, and storage of the orange in locally made storage structure was small when compared to alternative storage equipment such as, refrigerators and freezers. The storage facilities used are capable of being locally manufactured and maintained from materials that are locally available within the economic reach of the people at both the rural and urban levels.

UNIVERSITY-INDUSTRY LINKAGES (UIL)

From the foregoing, it is apparent that university-firm interaction is at its infancy at FUTA. However, if the university adopts a pro-active approach to setting its research priorities to agree with objectives of CERAD, there would be considerable potential for university-firm interaction, and evident impact on social and economic development would be realized. The constraints on UILs, as perceived by the officials of the university, can be enunciated as follows:

- The way in which research is conceived at FUTA is largely driven by individual researcher's perceptions of current issues and tendencies as their various fields demand. Interdisciplinary research that addresses real life problems are not promoted by the university's research programme.
- CERAD and BDC, which are the main university organs for promoting UILs, are relatively new and inexperienced. However, they are gradually establishing their presence with industries through services rendered, especially through consultancy projects.
- Poor research funding from government sources has remained a major deterrent to university-firm interaction. Research grants from the university's resources are grossly inadequate. Besides, firms are unwilling to release their funds for research in the university. The attitude of firms is not determined by whether or not they have confidence in the university, but rather by their interest and priorities. The interest of firms is primarily profit seeking. Firms believe that research collaboration with universities would not provide returns that can justify their investments in such endeavours.
- The mode of marketing of research outputs by the university is not attractive to industry. The method of packaging by the university is often at variance with the interests and needs of the industry. Research outputs should address the needs of industries. Industrial needs assessments should precede the initiation of research projects. This will eventually enable a better appreciation of the research outputs by industry.
- The process of application for FUTA research grants involves a rather complex application and administrative procedure. The university research grant committee and CERAD manage the university research grants. The research proposals from individual researchers or research teams are screened and peer reviewed. Only proposals that focus on current and topical issues in the country are funded. For instance, when bird-flu was discovered in Nigeria in 2006, a good number of researchers tailored their research proposals on the problem of bird-flu. The pre-qualification screening usually adopted by the university is competitive and stringent. Some researchers consider the administrative procedure too complex and discouraging to many good quality proposals. Even after the grant has been approved, the disbursement process is slow and

impeded by internal auditing procedures that often hinder the timely availability of funds for project implementation.

- The funds granted for university sponsored research is often not enough to carry out an approved research proposal. Consequently, many projects have been abandoned mid-way due to insufficient funds to complete them. The average amount of money granted to each researcher ranges from N150,000 to N300,000 according to the rank of the researcher.

Having emphasised that the UILs identified in FUTA are generally consultancy projects, we present a typical case demonstrated by FUTA's interaction with Grand Cereals and Oil Mills Limited (GCOML) (Jos, Plateau State), below.

UIL case of the Grand Cereals and Oil Mills Limited (GCOML)

The Grand Cereals and Oil Mills Limited (GOOML), Jos, Plateau State, is one of the foremost vegetable oil companies in Nigeria. The company evaluated its products with respect to the quality parameters of vegetable oil and discovered that rancidity, which could pose a major concern to consumers, may be a problem.

The company commissioned CERAD to find out if its main product, grand soya oil, gives an after taste to meat products fried with it, when stored under refrigeration and – if it does - determine how this could be corrected. CERAD took samples of grand soya oil and carried out the necessary analysis. A consumer survey was conducted purposely to obtain the consumers' perspectives on the issue of quality in the vegetable oil, especially rancidity.

CERAD was given the terms of reference by the company as follows:

- Investigate the development of rancidity of meat fried with grand soya oil;
- Determine the conditions that can cause the development of rancid flavor in the fried product; and
- Propose solutions that can reduce or stop the rancid after-taste of the fried product.

The project was carried out and the summary of the findings on consumer perspectives on vegetable oil quality and the laboratory investigations on rancidity, were presented to the company. In conclusion, the findings revealed that rancidity is not a problem that is peculiar with meat products fried with grand soya oil. Rather, it is a problem that arises as a result of refrigerated storage of the fried meat and breakdown of the unsaturated fatty acids during storage. The quality of the grand soya oil was discovered to be very high because its index of rancidity was much less than the NIS standard.

The investigations also revealed that the addition of BHT at the level of 300-400 mg/l minimizes the rancidity problem. It was thus recommended that if Grand Cereal Oil Mills Limited (GCOML) desires, it could use BHT to minimize the rancidity that may develop when fried meats are stored under refrigeration for up to four weeks before consumption. The addition of BHT, if it is to be used, should be at the production point, that is, on the refined fresh soya beans oil instead of the refined stored soybean oil. In the alternative, GCOML may use Butylated Hydroxyl Anisole (BHA) that is less volatile when heated.

This UIL case study typifies the nature of the limited university-firm interactions in FUTA. As indicated earlier, it is a case of a consultancy research project rather than active research collaboration.

CASE STUDY 3: UNIVERSITY OF IBADAN, IBADAN

UNIVERSITY VISION AND MISSION

The University of Ibadan was founded in 1948, by the colonial administration, as the first university in Nigeria.²² The university, which started with 104 students at its foundation, now has a student population of over 22,000, with approximately 35% postgraduate and 65% undergraduate students. At inception in the 1948/49, the university started as a College of the University of London and had only three faculties including the Arts, Science and Medicine. It became an independent and full-fledged university in 1962.²³ Presently, the university comprises of a college of medicine,²⁴ nine faculties, a postgraduate school, and a distance learning programme. The faculties include the Arts, Science, Agriculture and Forestry, the Social Sciences, Education, Pharmacy, Veterinary Medicine, Technology, and Law. The College of Medicine and the faculties have institutes and research centres that address more specific academic and societal challenges.²⁵ The Postgraduate School is the foremost in Nigeria. It has actually been decided that the University of Ibadan should gradually transform into a postgraduate institution with a ratio of 60:40 postgraduate to undergraduate students enrolment. This was informed by at least three main factors which include:

- the challenge of growing the Nigerian economy which requires high level skilled and innovative human resources;
- the need to produce doctorate graduates for the national university system, which has experienced an explosive demand for teaching and research manpower due to the establishment of several new universities in recent years; and
- the university's experience and highly qualified academic staff (including over 300 Professors and Readers and 292 Senior Lecturers)²⁶ is unrivalled in Nigeria.

²² As reported by the 'The Premier Tower' of June 2008 (Vol.1, No.1), the founding of the University of Ibadan followed the recommendation of the June 1945 Elliot Commission on the development of higher education in West Africa, that a University College of Nigeria should be established in Ibadan, a second in the Gold Coast (i.e. Ghana), and that the Fourah Bay College should be developed into a third University College. It was also recommended that only the University College in Nigeria should have a Medical School which would serve all the British Territories in West Africa.

²³ See the Vice Chancellor's statement on the history of the university on the university's website (accessed on 11 October 2008).

²⁴ The College of Medicine comprises of four faculties: basic medical sciences, clinical sciences, dentistry, and public health.

²⁵ A few of such research centres are the Institute of African Studies, the Institute of Education, the Institute Child Health, and the Centre for Urban and Regional Planning (CURP), Centre for Peace and Conflict Studies (CEPACS), Centre for Environmental Protection and Natural Resources, (CEPNAR).

²⁶ See 'The Premier Tower' of June 2008 (Vol.1, No.1, p.7). It is also reported in the Vice Chancellor's statement, on the university's website (accessed on 11 October 2008), that the university's Strategic Plan in the next five years includes building strong postgraduate programmes and research training capacity with academic staff growing from the present capacity of 1,200 to about 1,800 with about 400 in the professorial cadre.

The university's motto is the Latin '*Recte Sapere Fons*' translated, '*For Knowledge and Sound Judgment*'. Until recently, the university's vision has been 'to expand the frontiers of knowledge and transform the society through innovation', while its mission statement is 'to be a world-class institution where conditions for learning are excellent, research and services are outstanding and where staff and students are worthy in character and sound judgment'. The university prides itself highly in being the oldest university. It has the slogan, '*the first and the best*', which is chanted at every event where the university plays a prominent role. The university is celebrating its diamond anniversary this year, and it has been reported that the university recently renewed its commitment to excellence and leadership in Nigeria's knowledge industry through a strategic plan for the internationalization of the university. This resulted in the adoption of a new or revised vision and mission statements that are as follows:

Vision statement:

- To be a world-class institution for academic excellence geared towards meeting societal needs.

Mission statement:

- To expand the frontiers of knowledge through provision of excellent conditions for learning and research.
- To produce graduates who are worthy in character and sound judgment.
- To contribute to the transformation of society through creativity and innovation.
- To serve as a dynamic custodian of society's salutary values and thus sustain its integrity.

The pursuit of university renewal at Ibadan is aptly captured by the university's new strategic objectives enunciated in Box 14.

Box 14. The new strategic objectives of the University of Ibadan

- To re-awaken all staff and students to the need for rebuilding the University, and consequently inducing a drastic attitudinal change towards achieving the goal, by way of more commitment, greater loyalty and diligence on the part of all concerned.
- To make a more determined effort to generate adequate funding for the University, and so make it less dependent on government funding; and to ensure that any amount received is optimally utilized.
- To significantly improve the conditions for learning and research within the institution.
- To increase substantially, and in virtually all disciplines, the number of highly rated academics in Ibadan. Particular attention will be paid to Science and Science-related subjects, which have suffered the worst neglect over the years.
- To make the University of Ibadan more responsive to the needs of the country, other universities and our graduates.
- To update and modify our curricula for relevance to both national needs and global demands.
- To overhaul our recruitment process, and thereby ensure that only the best available hands are employed. The University will not allow extraneous factors like ethnic origin, race and religion to stand in our way of appointing the best candidate in any given situation. Recruitment will however, be as gender-

sensitive as possible.

- To ensure that we do not admit more students than we can cope with, taking into consideration the number of available staff and the facilities on the ground. However, to increase the number of people who can benefit from our services, the University will pursue vigorously the provision of long distance learning opportunities.
- To have a campus where there is peaceful coexistence, and in which members of staff of different disciplines and classes socialize with one another without inhibition, and staff and students alike relate and enjoy an environment conducive to the promotion of sound scholarship.

Source: The University of Ibadan Staff Information Handbook (2003)

INSTITUTIONAL CONDITIONS AND STRUCTURE FOR RESEARCH

Research at the University of Ibadan is carried out largely as an enterprise for knowledge generation and an academic component of its training functions. Most the research activities are student-project based. Besides individual research projects that attract funding from external agents through competitive bids, the government research funds, though grossly inadequate, are administered by the Senate Research Grants Committee. The problem of research funding has persisted for several years in spite of the notion that the University of Ibadan should take the lead in postgraduate training and research. While the policy of making postgraduate training the major component of the university has the support of the National Universities Commission (NUC),²⁷ there has been no evidence of significant support for the research which is expected to distinguish an institution devoted to postgraduate programmes. The reform efforts at the university and attempts to secure external support for the university's development programmes, gave birth to two key mechanisms that have supported research in recent years. These relatively new research support instruments are the university mission research programme and the MacArthur research capacity building programme.

The university mission research programme

The background to the university mission research programme was provided by the head of the university mission research programme. The concept of 'university mission research' actually came from the guidelines for the senate research grant which has been in existence for at least 40 years. The fund for the senate research grant is normally received from the NUC, which provides the statutory funding for the university system. The senate research grant committee is made up of the deans of faculties in the university. The senate research grant is distributed to cover all faculties. However, because the grant is usually grossly inadequate for serious research endeavours, it has had very limited impact. All the while, the clause in the guidelines for senate research grants, stating that research should be university mission-oriented, was never explored.

In 2002, a group of researchers in the university worked on the control and utilization of water hyacinth in Nigeria. The members were drawn mostly from the department of wildlife and fisheries, and the department of microbiology. After the completion of this project, another research topic was chosen with the theme "waste management". Based on this, a concept paper was submitted on waste management by a group of three

²⁷ The NUC is the government regulatory and administrative agency that regulates university programmes and oversees their funding and management.

professors one of which had previously served as a member of the senate research grant committee. It was conceived that since environmental protection would be one of the main pre-occupations of mankind in the 21st century, waste management would be one of the biggest challenges of mankind because an individual generates 1-2 kg of waste daily. This is a problem that affects human health, industries, environment, etc. It was reasoned that any research effort that effectively tackles any aspect of the environmental challenge could have a profound global impact. The research proposal's main objective was to manage waste in order to generate value and thereby turning waste to wealth. The research theme thus emphasizes the notion of "waste-to-wealth". The proposal was originally submitted as a proposal from the Faculty of Agriculture and Forestry. The senate research grant committee was fascinated by the proposal and then decided that because of its global relevance and application, it should be adopted as a university wide research programme, cutting across all faculties in the university. It was at this stage that the idea of the university mission research programme (UMR) was conceived, and reference was made to the appropriate clause in the guidelines that enabled it to apply for the senate research grant. The waste-to-wealth projects were expected to turn wastes into useful things that could generate revenue and employment opportunities, and keep our cities and environment clean, thereby promoting good health and a healthy environment:

The waste-to-wealth projects are multidisciplinary in nature, and involved eight out of the 10 faculties in the university. The project theme was divided into 14, which translated into 14 research projects and project team leaders. Each project team leader was asked to submit a fresh research proposal on the appointed new theme. The senate research grant committee considered the new proposals under the UMR programme. The UMR projects had a duration of three years and a total budget of N64 million. However, the total research budget for the university in the 2002/2003 session was N22.6 million. Hence, the university was only able to give N22.6 million, which translated to about 30% of the total project costs. The research budgets were accordingly pro-rated to cater for 30% of the budgetary submissions of each UMR project. The approval of the UMR projects changed the focus of the university research grant allocation from fragmentation of research funding to several unrelated projects, to funding of a major and comprehensive research programme that has relevance to the needs of the society. The UMR programme was domiciled at the Centre for Environmental Protection and Natural Resources (CEPNAR), and the Director of CEPNAR serves as the head of the UMR programme.

So far, the UMR has delivered 13 project reports detailing research outputs, five of which has been patented by the university.²⁸ Twelve technologies that can be commercialized have emerged and some of these include:

- Recyclable nylon pellets developed from used sachet water nylons.
- Design and fabrication of a machine for the production of fingerlings for commercial purpose,
- Development of floating fish feed pellets that can stay afloat in water for more than 24 hours, thereby reducing wastages.
- Development of single-cell protein (from cassava peels) with little nutritive value into 100% protein, through the isolation of the right bacteria (this invention was

²⁸ Thirteen research findings have actually been sent for patenting rights, with five already patented.

developed by three departments from three different faculties and to some extent, employed biotechnology).

- Design and fabrication of an electrical machine for binding. The machine will not use starch, but some waste fluid from cassava peels.
- Design and fabrication of a waste paper re-cycling machine for cottage industries.

The constraints on UILs, as perceived by the head of the UMR programme, are presented in Box 15.

Box 15. Constraints on UILs as perceived by the head of UMR programme

- Lack of drive towards the commercialization of research outputs by the university. Very few people know what the university has achieved through the UMR. The UMR as a unit within the Centre for Environmental Protection and Natural Resources (CEPNAR), cannot advertise itself. It depends on the university to do so. The objectives of the adverts must be well defined and focused for people to know and appreciate the outputs of UMR. If the purpose of the advert is to commercialize the findings, then the focus should be on the private sector organizations. This will help build the relationship needed with the industries. Since the inception of UMR, the university has taken part in two organized research output fairs by the NUC at Abuja and Lagos. However, these fairs did not yield the desired impact or results, as the industries were not present. Since 2005, the achievements of the UMR have been hidden or locked-up within the university, since nobody has shown keen interest in promoting them.
- Poor attitudes of Nigerians towards locally made goods. Nigerians do not value locally made products as they prefer imported machines and consumer goods. This is aided by a lack of good examples by government and political leadership, which often patronize foreign made goods and services even when there are locally produced equivalents that offer value for money.
- The standard of education in Nigeria has fallen over the years, resulting in a crop of poorly educated researchers and scientists. The fall in education started from the late 1970s when the condition of service of university lecturers began to depreciate. This led to mass exodus of experienced Nigerian lecturers abroad. It also coincided with the emergence of the dominance of the oil economy, which made conditions of service in the oil related businesses and foreign companies more attractive to the academics.
- The lack of practical approaches to education was also a major set back which is yet to be tackled. University education in Nigeria has been regarded as a license to paid-employment rather than an instrument of skills acquisition.
- The university has been reluctant to make conscious efforts to popularize its research findings. Research has been done solely for contribution to knowledge and publication to earn academic promotion.

MacArthur research capacity building programme

The MacArthur Foundation²⁹ has been supporting the University of Ibadan since 2002 as part of the foundation's efforts to improve higher education in Africa. The foundation has provided grants aimed at supporting research and capacity building towards the repositioning of the University of Ibadan as a leader in teaching, learning and research. The grants have been given for three-year periods: 2002-2004, 2005-2007, and 2008-2010. The first grant was a capacity and infrastructure development grant, and thereafter, the grant became all-encompassing with major research components. The latest grant of US\$4 million for 2008-2010 is for the equipping of a multi-purpose central research laboratory for the university,³⁰ to continue staff training,³¹ to increase research collaboration with foreign universities, to invest in information technology infrastructure, to advance library automation, and to enable the university to expand access to higher education by increasing enrolment in its accredited distance learning programme from 7,000 to 25,000 students by 2010.

The staff development component of that grant enables lecturers to travel abroad for periods ranging three to 12 months to gain international exposure and acquire up to date skills and knowledge in their fields of expertise. The beneficiaries are also provided with re-settlement grants which support their return to settle down and continue with their teaching and research in the university.

There is no particular research agenda or focus for the research component of the grants. It is simply meant to strengthen the university research capacity and support research into issues of interest to the university. The grant supports multi-disciplinary research projects and respects the university's freedom to embark on scientific enquiry. In administering the grants, the university considers research proposals from every faculty, and proposals are approved for funding after it has successfully passed through a thorough review process. The Foundation encourages multi-disciplinary research as this enables collaboration in all disciplines.

The director of the MacArthur research and capacity building programme of the university observed that 70% of the research and inventions today are done in industries, while only 30% is carried out in the universities. It was pointed out that Nigeria does not have industries that carry out research locally. Nigeria serves as an outpost for numerous multinational companies which seek to sell their products without any commitment to R&D in Nigeria. The firms already have overseas partners or have parent companies that carry out their R&D activities. Data is collected from Nigeria and sent to R&D departments abroad for processing and analysis. Moreover, competition among Nigerian firms is weak. Where there is lack of competition there cannot be enough incentive for R&D collaboration. The mind-sets of Nigerians in preferring things from abroad, creates a big obstacle to UIs and hinders the competitiveness and growth of local firms. The government offering consultancy projects to companies overseas, to the detriment of the university, is another major hindrance to UIs.

²⁹ John D. and Catherine T. MacArthur Foundation, Chicago, United States of America. It has been reported that the foundation has provided about US\$12.6 million in grants to the University of Ibadan, from 2002 to date. See 'The Premier Tower', Vol.1. No.1 (p.33), June 2008

³⁰ It was indicated during this study's fieldwork that the new research equipment ordered, has started arriving and are being set-up, while others are being awaited.

³¹ The goal is to train 2,100 staff members including, faculty, administrative and technical workers over the next three years. See 'The Premier Tower', Vol.1. No.1 (p.33), June 2008.

The director disclosed that the challenges posed by the constraints may be addressed by education and advocacy programmes. The university curricula should be reviewed to reflect the dynamism in society and industry. There should be continuous interaction between university and industry to bridge the wide gap between them. Universities that have upgraded their research and teaching to world-class standards would be approached by industries that are dynamic, due to competition in the economic environment. The government can be the catalyst of the interactions by providing adequate support for research and use of Nigerian university experts rather than foreign consultants. Government's poor support for research activities has also been a hindrance to spin-off effect. The multi-disciplinary research focus of the Foundation's research grants may provide opportunity for spin-offs if government policy is supportive.

RESEARCH IN AGRO-FOOD PROCESSING

Research in agro-food processing at the University of Ibadan is one of the oldest in Nigeria. The departments of Food Technology and Agricultural Engineering of the University, where agro-food processing research is based, are among the first sets of academic programmes of the Faculty of Technology. From the information obtained from the university website,³² the Faculty of Technology began with the idea of an Institute of Applied Science and Technology in the University of Ibadan in 1967. The National Universities Commission (NUC) had directed that 70% of the total student enrolment in Nigerian universities should be in Science and Technology. In accordance with this policy, the Commission gave approval for the establishment of the institute, which was supposed to be inter-disciplinary in structure and mandated to facilitate greater integration between academic studies and the industrial, social and economic needs of Nigeria, by generating technology for the nation's industrial development and technological advancement. The recognition of the need for a wider variety of trained personnel in technology - than was available from the then existing faculties of engineering in the country - informed the proposal that the Institute should offer both first degree and post-graduate diploma programmes in the areas of agricultural products processing including, food and fibre, mineral technology, and chemical and plastics technology. It was reported that the Canadian International Development Agency (CIDA) supported these programmes with the provision of equipment and some specialized teaching staff in the initial three- to five-year period and engaged in counterpart training whereby Nigerians were trained to fill specialized teaching posts as Canadian experts terminate their duty cycles. The programmes started in the 1972/73 session with twelve senior staff members (five were supplied by CIDA) and 50 pioneering students drawn mainly from the Faculties of Science, Agriculture, Forestry and Veterinary Science. These were admitted to the first and second years of the degree and diploma programmes. Food technology was one of the seven programmes operated (from inception) by the institute.³³ With the transformation of the Institute to the Faculty of Technology in July 1975, the seven programmes were regrouped into four academic departments, which included the Department of Food Technology³⁴. The department

³² The official website of the University of Ibadan, accessed on 09 June 2008.

³³ The other six programmes were Agricultural Engineering, Forestry Engineering, Wood Processing, Machine Design Engineering, Instrumentation Engineering, and Petroleum Engineering.

³⁴ The other three departments were: Department of Agricultural Engineering offering programmes in agricultural engineering and forestry engineering; Department of Design and Production Engineering offering programmes in machine design engineering, instrumentation

thus became one of the oldest departments of food technology in the Nigerian university system.

In addition to the agro-food processing research projects identified under the UMR programme (discussed above), other important agro-food processing research that has taken place within the last three years, mainly within the Faculty of Technology, include:

- i) Research on the application of solar energy in drying and cooking.
- ii) Application of imaging for quality inspection.
- iii) Determination of engineering properties of food crops.
- iv) Research on cassava processing and cassava products in collaboration with IITA, RMRDC and FIRO.
- v) Investigation of the feasibility of 10% cassava flour in wheat flour for bakery products. The project examined the baking characteristics of cassava flour and compatibility with products, preservation and storage.
- vi) Design and fabrication of oil expellers, with particular focus on beni-seeds (i.e. sesame seeds).
- vii) Improvement of palm kernel oil expression using crude press.
- viii) Formulation of the agricultural properties of pine-apple concentrates into powdered form without any additives.

With specific reference to agro-food processing, the researchers/lecturers interviewed identified the following constraints on UILs:

- Poor government funding of research.
- Local firms come regularly to seek help, but disappear when charged to pay for services.
- Lack of basic infrastructure such as, regular electric power supply, a modern research laboratory, food halls to display research findings and scale-up facilities or demonstrative plants to help expose research findings.
- Lack of understanding of the roles to be played by all stakeholders, that is, the researchers/scientist, entrepreneurs and the government.
- Ego and attitudinal problems: academia believes it is superior to industry in terms of knowledge, while industry believes it is superior in terms of turning knowledge into money, and thus the one does not perceive the need for the other.
- Non availability of high quality engineering materials for the fabrication of prototype food processing equipment. For example, stainless steel is not produced locally and as such, most of the steel used locally are not of satisfactory quality.
- The emphasis on 'publish or perish' is a deterrent to UILs. It should be replaced with 'patent, publish and flourish'. This will encourage a working relationship with industry.
- Some research projects in agro-food processing do not have the potential for forming linkages with industry to attract appropriate funding from industry or government. It would therefore be helpful if, before any research kicks off, it

engineering and food engineering; and the Department of Petroleum Engineering. These departments have undergone further restructuring into the current seven departments in the Faculty of Technology, which include the Department of Agricultural Engineering offering both agricultural engineering and wood products engineering; Department of Civil Engineering; Department of Electrical & Electronics Engineering; Department of Industrial & Production Engineering; Department of Food Technology; Department of Mechanical Engineering; and Department of Petroleum Engineering.

already has an industry linkage that may involve indigenous entrepreneurs, small-scale industries or medium and large firms.

AN EMERGING FRAMEWORK FOR UILS

Existing UILs³⁵

There are some forms of formalized linkages between industry and the University of Ibadan. A well known example is the training of students by firms in the Students' Industrial Work Experience Scheme (SIWES) or industrial training (IT) attachment, funded by the Industrial Training Fund (ITF).³⁶ SIWES is especially mandatory for academic programmes in the faculties of Technology and Agriculture in Nigerian universities. Under SIWES, firms are not under any obligation to accept students or pay the students a stipend during the IT. The onus rests on them to augment the students transport fare, if they so desire. This problem led to the Faculty of Technology designing a training programme, for the mechanical engineering students, a few years ago. The programme is designed in such a way that 200-level students undergo industrial attachment with local auto-mechanics of the informal sector to gain some rudimentary practical training, while the 300- and 400-level students go on similar attachments with reputable firms or industries for a specified period. This was also done under the notion that real engineering training takes place at the 300 to 400 levels.

The research links of researchers/lecturers with industry are informal and personalized as the university only creates the enabling environment. These personal level contacts have however resulted into a formalized memorandum of understanding (MOU) being entered by some industries with the University of Ibadan. Some MOUs entered include MOUs between the University and OMATEK computers, and ZINOX computers, while negotiations are still on-going with IDEA consults - all skewed to the Information Technology (IT) industry. These MOUs involved the training of students on IT, exchange programmes, provision and acquisition of computers at moderate prices, provision for sabbatical leave for researchers, and occasional lectures by IT professionals. It was also reported that some ad hoc informal collaboration with local firms exist in the form of consultancy to solve production related problems.³⁷

There are two chairs endowed to the faculty by some organizations. They include Shell Petroleum Development Company (SPDC) and Petroleum Technology Development Fund (PTDF). In food technology, there is also the West African Milk Company (WAMCO) endowment for research in dairy technology, supports student research and awards for the best graduate of food technology.³⁸

³⁵ This subsection draws largely from the transcript of interviews with the Dean of the Faculty of Technology, the Head of Department of Food Technology, and the Director of the Centre for Entrepreneurship and Innovation.

³⁶ SIWES is a type of limited UIL that exists in all the university case studies.

³⁷ A good example of this was an investigation of the feasibility of including 10% of cassava flour in wheat flour, a few years ago. A scientist in the Department of Food Technology was commissioned by Flour Mills of Nigeria, Apapa, to carry out the study. The project examined the baking characteristics of cassava flour and compatibility with products, preservation and storage.

³⁸ The WAMCO endowment started some years ago with about N30,000/year, which is now N100,000/year. The endowment provides a prize of N10,000 to the best graduating student and supports student-based research on dairy products.

From the interviews conducted with relatively old and experienced professors, there are indications that the University of Ibadan has a long history of interaction with firms. Box 16 provides the view of a professor who has worked at the University of Ibadan for 40 years and had researched into agro-food processing. However, in the formal sense of the university helping to solve societal problems and having the authorization to do it, this is a recent development. It may be instructive to consider the university-industry linkage from two perspectives: what the industry does to help build the university in terms of infrastructure, and what the university gives back to industry as part of the results of its teaching and research. The first part has existed for a long time, albeit in a small way. The second part started on a formal scale in the University of Ibadan, with the setting up of firstly, the University Consultancy Services in the 1980s. It grew to become the Centre for Resource Management and Consultancy (CEREMAC). All of the commercial units in the University fell under CEREMAC, like a holding company, but at that time the university was not ripe for such a development. This was because the University of Ibadan, having developed under the British concept where the university was meant to train just a few professionals or to train people for government jobs, it was not generally acceptable for the university to deal with society. At that time, the 'Iyan'³⁹ research project was carried out. The project produced the first powdered yam tasting like 'Iyan', which was produced at a plant built by a Nigerian professor at the university. Also, the Department of Chemistry practiced 'waste-to-wealth' research whereby used broken bottles were processed to make a mixture that was used as terrazzo⁴⁰ at that time. CEREMAC has since folded up, but was later revived as the University of Ibadan Ventures (UI Ventures), which became a holding company and a limited liability company.

Box 16. Decline in UILs

- There have been a lot of spin-off companies from the university-industry linkages in agro-food processing in the early stages - in the 1960s and early 1970s. Pfizer feeds, livestock feeds, and most poultry feeds industries situated around South West Nigeria, are some examples of such relationships. The quality and dedication to research became diluted over the years when the funding of universities was drastically reduced, from the late 1970s. Following this trend of funding, the mind set of the academics and industry equally changed. The exodus of the Nigerian academics began, and industry was no longer willing to take risks or go into partnership with the universities.
- The nature of education presently offered by the university does not stimulate risk taking and venture into some productive activities. For example, there is no major agricultural farm owned by any Nigerian university. Agriculture is currently not looked at as a business from the mindset of the educational system. Agriculture-related education should be made more attractive and practically oriented. Universities should have business plans to make agriculture work within its training curriculum. The University should go into partnership with industry in order to develop and interact effectively in the agricultural sub-sector. Agro-food processing provides a lot of employment opportunities, which university-industry linkages could turn into a reality that is of immense help to society.

³⁹ 'Iyan' is a local popular delicacy.

⁴⁰ Terrazzo is a form of permanent floor tiles.

As observed by the Dean of the Faculty of Technology, the mindsets of the industries have never been inclined towards research collaboration with the universities for the following reasons:

- Multi-national companies with headquarters overseas have no incentive to carry out R&D in Nigeria.
- The major problem encountered by the university scientists have been that of insulation from the industries. Their paths do not normally cross as the various missions differ. While the lecturer/scientist is on the mission of 'publish or perish', without recourse to outside or industries' needs, the industries are on a mission of 'profit'. Lecturers/researchers need to change their attitudes and perceptions towards industry, and industry needs to better understand the researchers and their findings in order to build a mutual understanding.
- The funding of universities is mainly done by government, which does not provide adequate funds for research.
- The university has not focused on its research mission to align any research to its "mission and vision". The University of Ibadan started mission-oriented research with the concept of 'waste-to-wealth' under the UMR only recently.⁴¹ With this, the funding of research is better focused, and as a result it has increased.⁴²
- The university research output and productivity is relatively good, when viewed in comparison to local performance. The culture of 'publish or perish' has been a major driver of research and thus, the self interest of the researchers has enabled considerable research productivity. Although the university produces publications, a lot remains to be achieved, especially because research funding is very limited. The *total* research fund of the university is not comparable with funding for a *single* research project at many renowned universities abroad. Apart from the funding constraints, getting the university staff and industry to change attitudes, are major challenges to be tackled. The researchers should imbibe a culture of conducting research that is based on real life problems and seek to involve industry. Industry should also show interest in research carried out in the universities.

⁴¹ Prioritization of research started about five years ago. The university now has a university research vision that is aligned with the university vision and mission. The university research vision is based on the concept of 'waste-to-wealth', which essentially aimed at encouraging research that investigates issues of how to clean up the waste generated in production and consumption activities, and develop products and services that significantly contribute to human development. Prior to the prioritization, research grants were ridiculously small and researchers viewed them as a pretext for 'sharing of the national cake'.

⁴² It was reported that the Nigerian Universities Commission (NUC), on identifying the importance of research, has recently increased the university subventions on research. This has impacted on the research grants such that, an individual researcher can be funded up to N600,000, while multi-disciplinary research grants can be up to N4 million.

Centre for Entrepreneurship and Innovation⁴³

The University of Ibadan Centre for Entrepreneurship and Innovation (CEI) was approved by the University Senate on 28 January 2008. Prior to this approval, since 25 June 2005, it operated as the Programme for Entrepreneurship and Innovation under the Department of Economics. The CEI is aimed at promoting university-private sector collaboration, teaching and research in entrepreneurship and innovation, and the direct relevance of the university to its environment and the society at large. It seeks to complement the effort of government in promoting private sector-led growth as envisioned in national and continental policies and initiatives such as, the National Economic Empowerment and Development Strategy (NEEDS), the New Partnership for Africa's Development (NEPAD), the National Programme on the Eradication of Poverty (NAPEP), and the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN). The vision of CEI is, "to be the leader in positively transforming society through entrepreneurship and innovation", while its mission is,

to unlock the entrepreneurial ideas in students, staff and operators of small and medium enterprises, through training and other interventions, to enable them to develop sustainable enterprises by utilizing mutually rewarding partnerships with private sector, policy-makers and non-governmental organizations committed to economic growth, poverty alleviation and sustainable development.

The emphasis of CEI on university-private sector collaboration is apparently synonymous to the concept of UILs in this study. Hence, the vision and mission of CEI is essentially focused on prompting UILs involving the University of Ibadan and the industries in its immediate environment.

The main objective of the centre is to institutionalize the development of entrepreneurship and innovation through teaching, research, networking and advocacy, as well as collaboration with the private sector and government. Its specific functions include:

- Curriculum development in entrepreneurship and innovation;
- Coordination of teaching and research in entrepreneurship and innovation;
- Promotion of linkages with the private sector, through research, consultancy, training and building networks and alliances;
- Development of appropriate approaches for promoting innovation among entrepreneurs, particularly of small businesses and students; and
- Development of modalities for promoting linkages with government, including building appropriate institutional and legal frameworks for enhancing university-private sector collaboration in Nigeria.

The CEI has signed an MOU with a number of private sector organizations, and developed proper partnership with about 15 of them, for running the centre, teaching courses and in terms of training and contact. It is currently conducting a needs assessment survey of enterprises in Ibadan and environs so that evidence can be used to determine their needs, especially the problems they would like the university to solve for them. CEI is also taking an inventory of research of staff, projects and theses of students that have commercial potential, so that the intellectual property they produce

⁴³ This section draws largely from the transcript of the interview with the Director of the Centre for Entrepreneurship and Innovation, and from the University of Ibadan Official Bulletin No. 2241, 23 July 2008.

can be developed and necessary assistance can be given to commercialize them. In the 2008/2009 session, there is a plan to develop, in collaboration with management and staff, the University of Ibadan Intellectual Property (IP) Policy. The policy will guide the operations of the IP developed by staff and students. The CEI will also commence the teaching of a 300-level course on 'Basic Entrepreneurship and Innovation' aimed at qualified undergraduates who had attended the Workshop on Entrepreneurship and Innovation for 200-level students.

The office of the CEI is located outside of the university, in close proximity to industrial sites, because it is believed that UILs would thrive if the university is visible to industry. Later this year, the CEI plans to organize an event called the 'University of Ibadan Entrepreneurship and Innovation Forum'. The centre will also fund students' business ideas that have the potential to succeed. Students will compete for funds and the winners would be announced at a well publicized event, as a means of promoting UILs.

It was reported that the university is currently preparing a comprehensive strategic plan of research and development, which would be under the office of a Deputy Vice Chancellor (R&D). In the view of the director of the CEI, the major constraint to commercializing research outcomes relates to attitude and pre-conceived notions of industry and researchers/lecturers. On the one hand, the industry thinks that the university system in Nigeria is not equipped to address what they need. They would rather go to other countries to get their problems solved. On the other hand, the academics think they need the research just to be promoted to the level of professor, and not necessarily to improve industrial production or society. The physical constraints include, getting the funds to commercialize the research results and poor infrastructure for research and industrial production.

CONCLUSION

This study examined university-firm interaction from the perspectives of selected Nigerian universities. Two specialized universities (one university of agriculture and one university of technology) and one conventional university were chosen as case studies to illustrate the state and intensity of knowledge intensification in agro-food processing in Nigeria, and the contribution or otherwise of university-industry linkages (UILs) to the knowledge requirement for the development of the sector.

The findings of the study revealed that the universities have distinguishing features in their research culture and vision; and that the state of knowledge intensification in agro-food processing in the three universities differ considerably, as demonstrated by the nature and extent of the UILs identified.

The research culture and vision of UNAAB appear to be relatively well established, there is a relatively firm institutional structure and well articulated framework for research. The development of the agricultural sector and agro-food processing form the major focus of UNAAB, and there is ample evidence of research (both on-going and completed) in agro-food processing. Biotechnology is recognized and promoted by UNAAB as an important technology platform for increasing food production and industrial technology development for agro-food processing. However, biotechnology research and application are still highly limited and constrained, especially by lack of research infrastructure and necessary funding support. Biotechnology firms in Nigeria are currently non-existent,

and agro-food processing firms that apply biotechnology are yet to appreciate the existence of local competence in this sector. It is, however, apparent from the findings that modern biotechnology is still an emerging technology in Nigeria and support for its development is currently weak.

As a university of technology, FUTA's focus is biased towards building local technological capability. In this respect, the development of agricultural technology, especially aimed at tackling the challenges of post-harvest losses, has been a major concern at FUTA. However, the institutional framework for research at FUTA appears relatively less developed compared to UNAAB, and there is no evidence of existence of significant research in biotechnology.

The University of Ibadan (UI) is the oldest and more experienced of the three universities. Although the research culture and institutional framework for research are well established, the evolution and transformation of the knowledge generation mechanisms have been slow. The challenge of orienting the research activities to address the new vision and mission of the university has resulted in considerable transformation of the research culture of the university. Research in agro-food processing has been a major beneficiary of this transformative process. Although there are indications that the research infrastructure is being significantly improved, especially through on-going major support from an international organization, it is unclear whether the university is consciously promoting the application of biotechnology in agro-food processing research.

While UNAAB presented two interesting cases of UILs, FUTA presented only one, and none were identified at the University of Ibadan (UI). The two UIL cases at UNAAB showed that there is potential for developing knowledge intensive university-firm interaction. However, the constraints are diverse and presently becloud efforts to advance the limited success that has been achieved in the two cases of UIL. In the case of FUTA, the UIL is noted to be in its infancy and the case illustration is a consultancy research project - which typifies the examples of UILs in which FUTA has participated thus far. Although UI has no example of UILs, the university demonstrated ample knowledge of the rationale for UILs and showed remarkable efforts aimed at transforming the research activities of the institution into a dynamic system that fosters UILs.

The evidence of university-firm interactions from the perspective of the university, presented by the three universities, confirms that UILs in Nigeria are rare. The university and firm officials interviewed emphasized the constraints on UILs and the challenges posed by the constraints. The main constraints identified may be classified into three categories:

- infrastructure related
- policy related
- attitudinal related

Infrastructure related constraints include poor research facilities and equipment, poor electric power supply, poor access roads and inadequate communication infrastructure. Policy issues that constrained UILs include the lack of incentives, poor government support for industry R&D and poor funding of research. Attitudinal issues that constrain UILs include the lack of political will to address R&D challenges, an entrepreneurship

culture that lacks support for R&D and divergent perspectives held by scientists and industrialists.

REFERENCES

- Adeniji, A.A. (2007). Cassava Varieties for Ethanol. A paper presented at the first International Ethanol and Biofuels Conference, Abuja, Nigeria, 29-30 March 2007.
- AMREC. (2007). *Agricultural Media Resources and Extension Centre (AMREC): Annual Report, 2007*, University of Agriculture, Abeokuta, Nigeria.
- Biotech Centre. (2007). *Brochure on endowment appeal for biotechnology and bioinformatics infrastructure*, University of Agriculture, Abeokuta, Nigeria.
- CBN. (2007). Central Bank of Nigeria Annual Report and Statement of Accounts 2006, Central Bank of Nigeria, Abuja.
- CERAD. (2007). Corporate Profile of the Centre for Research and Development, Federal University of Technology, Akure.
- FUTA. (2005). Federal University of Technology, Akure: Calendar 2005 – 2007.
- JAMB. (2007). UME/DE Brochure for 2008/2009 Academic Session: Guidelines for Admissions to First Degree Courses in Nigerian Universities, Joint Admissions and Matriculation Board (JAMB), Office of the Registrar, JAMB, Abuja, Nigeria.
- Nweke, F. I., D.S. Spencer, and Lynam J.K. (2001). *The Cassava Transformation: Africa's Best Kept Secret*. Michigan State University Press, East Lansing.
- Oyewole, O.B. (2008). Internationalization of the University of Agriculture, Abeokuta, Lecture presented under the A.G. Leventis Memorial Centre for Learning (LEMCEL), University of Agriculture, Abeokuta, Nigeria. 25 June 2008.
- The University of Ibadan Staff Information Handbook (2003). Staff Information Handbook: Rules and Regulations Governing Conditions of Service of Senior Staff, Publications Unit, Office of the Registrar, University of Ibadan/Ibadan University Printery, Ibadan, Nigeria.
- UNAAB. (2007). *University of Agriculture Abeokuta, Nigeria: 2005/2006 and 2006/2007 Undergraduate Prospectus*, Ibadan University Printery, Ibadan.

APPENDICES

APPENDIX 1. CASE STUDY RESEARCH INSTRUMENTS

APPENDIX 2. LIST OF STAKEHOLDERS INTERVIEWED

The case of the University of Agriculture, Abeokuta

1. Dr. M.A. Idowu, Head of Department of Food Science and Technology.
2. Prof. S.O. Awonorin, Dean College of Agricultural Management, Rural Development and Consumer Studies (CLAMRUCS).
3. Prof. I. Akpan, Department of Microbiology
4. Prof (Mrs) Sylvia Uzoichukwu, Director, Biotechnology Centre
5. Prof. F.K. Salako, Director, Agricultural Media Resources and Extension Centre (AMREC).
6. Dr. Lateef O. Sanni, Department of Food Science and Technology and Director, AG Leventis Memorial Centre for Learning (LEMCEL).
7. Dr. T.A. Shittu, Lecturer/researcher, Flour & flour products specialist; Department of Food Science and Technology.
8. Dr. O.P. Sobukola, Lecturer/researcher, food processing and storage technology; Department of Food Science and Technology
9. Prof. I.O.O Aiyelaagbe, Director, Research and Development Centre (RESDEC)
10. Prof. O.J. Ariyo, Crop Scientist-Soyabean breeder, Deputy Vice Chancellor (Development); former Dean of Postgraduate School.
11. Mr. I.A. Adeniji, Chief Extension Officer, Agricultural Media Resources and Extension Centre (AMREC).
12. Dr. Adenekan, Corporate Relations Manager, Nestle Nigeria PLC.

The case of the Federal University of Technology, Akure

13. Prof. J. Fashakin, Head of Department of Food Science and Technology
14. Prof. B.O. Adewumi, agricultural engineer and environmental scientist.
15. Prof (Mrs.) Osundahunsi, specialist in food quality control, food chemistry & nutrition.

16. Dr. T.N. Fagbemi, Senior lecturer and specialist in quality control, food chemistry and processing.
17. Dr. Ade Oguntade, agricultural economist and acting Director of Centre for Research and Development (CERAD)
18. Engr. M.O. Oluwamukomi, Senior lecturer and specialist in food processing and product development.
19. Engr. J.A. Famurewa, Senior lecturer and specialist in food processing.
20. Prof. R.O. Abiola, Head of Department of Management Technology.

The case of the University of Ibadan, Ibadan

21. Prof. G. O. Adegoke, Head of the Department of Food Technology
22. Prof. Ayo Oluleye, Dean, Faculty of Technology
23. Prof. O.O. Tewe, specialist in agricultural biochemistry, Department of Animal Science; member University Mission Research Committee.
24. Prof. S.S. Ajayi, Chairman, University Mission Research Committee
25. Prof. A. Soyibo, Director, Centre for Entrepreneurship and Innovation.
26. Prof. G.O.S. Ekhaguere, Chairman MacArthur Foundation Grant Committee.
27. Dr. A. Akinoso, agricultural engineer and lecturer/researcher in food technology.
28. Dr. A.O. Rahji, agricultural engineer and specialist in modeling and design technology; Director Management Information System.
29. Mrs. P.I. Ozo-Peters, food scientist and lecturer/researcher.