

**Knowledge for Development: University-Firm Interaction  
in Sub-Saharan Africa**

**NIGERIA COUNTRY REPORT\***

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**ABSTRACT**

This study analyzes the policy mechanisms underlying the National System of Innovation (NSI) in Nigeria and constraints on university-firm interactions from the perspectives of firms and selected Nigerian universities. An industry survey was carried out; and three universities were chosen as case studies to examine the state and intensity of university-industry linkages (UILs) in agro-food processing. It was shown that though Nigeria has made diverse attempts to develop science and technology (S&T), until 2007 development planning process failed to appreciate the central role of science, technology and innovation (STI) in economic and social development. The results of the firm survey demonstrated that conditions in the firm that constrain university-firm interaction can be broadly classified into two: firm's limited R&D capability, and firm's low perception of the quality of knowledge from the universities. The evidence of university-firm interactions from the perspective of university practice confirmed that UIL is rare in Nigeria. The main constraints identified may be classified into three: infrastructure related, policy related, and attitude related. Three UILs were identified, and they illustrated how UILs in agro-food processing has worked in Nigeria. The three UILs were characterized as principal agent demand-driven, multi-stakeholder problem based, and arms length consultancy. From the evidence presented by the UILs, inter-organizational relationships appear to be weak and the role of the state is still not remarkable in supporting or promoting UILs. In effect, the results of the firm survey showed that firms seek other sources of knowledge for innovation apart from universities; while the case study of universities demonstrate that UILs that result in knowledge intensification in agro-food processing are not deliberately promoted. The three examples of UILs however underscore the fact that there are potentials for UILs among Nigerian firms and universities, and policy framework that encourages UILs would be beneficial.

**Keywords:**

University-firm interaction, knowledge intensification, R&D, national system of innovation, agro-food processing, Nigeria

# Knowledge for Development: University-Firm Interaction in Sub-Saharan Africa

## NIGERIA COUNTRY REPORT

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### I. INTRODUCTION

This paper presents the report of the Nigerian aspect of a broader study that investigates the state of university-firm interactions in three African countries at different levels of development - South Africa, Nigeria and Uganda. Under the IDRC RoKS programme, the research examines how and why university-industry linkages (UILs) differ, focusing on incentives and constraints, as well as on their extent, intensity and performance of UILs. This is expected to provide a basis to consider the contribution universities make to local and national development goals. Each country study focuses on a specific sector. In Nigeria, positive network relationships between knowledge producing institutions and knowledge users are rare (Brautigam 1997, Oyeyinka 1997, Okejiri 2000, Adeoti and Adeoti, 2005). This notwithstanding, an important potential beneficiary of UILs is the agro-food processing sector which accounts for one quarter of manufacturing value-added. For the Nigerian case, the main research question is what are the constraints on and opportunities for knowledge-intensification of firms in the agro-food processing sector through interaction with universities? Successful agro-allied processing would rely on knowledge inputs from universities, especially in view of the low firm-level R&D in Nigeria. The main objective of the study is therefore to identify constraints on and opportunities for knowledge-intensification in such a key resource-based sector. The specific objectives are to:

- i) analyze the context of the National System of Innovation with the identification of the policy mechanisms that have shaped technological development in Nigeria;
- ii) identify the conditions in the firm that constrain university-firm interaction;
- iii) ascertain the conditions in the university that constrain university-firm interaction;
- iv) examine the outcomes of identified university-firm interaction to demonstrate whether or not the interaction work/succeed;
- v) ascertain whether or not there are emerging opportunities for knowledge intensification in agro-food processing; and
- vi) present suggestions for policy aimed at stimulating university-firm interaction in Nigeria.

The rest of the paper is organized as follows: the next section presents the research methodology; section three examines the policy mechanisms underpinning the national system of innovation in Nigeria; section four discusses the features of the conditions that constrain university-firm interactions; section five presents an analysis of the identified UILs; section six examines the opportunities for knowledge intensification in agro-food processing; and the final section presents the conclusions and policy implications of the findings.

## 2. RESEARCH METHODOLOGY

The methodology for the study has three components. The first entails policy account and review of existing empirical literature on economic and technology development activities in Nigeria in order to set the economic and technological development background for the analysis of the university-firm interactions. The second component involves a survey<sup>1</sup> of firms in the Nigerian manufacturing sector aimed at providing data for the analysis of firms' perception of UILs. The third component comprises the case study of university practice aimed at providing information for the analysis of university perception of UILs. The first component would address objective (i) of the study while objectives (ii), (iii), (iv) and (v) would be addressed by the second and third components. Objective (vi) would be addressed by the policy implications of the study.

While the first component of the methodology is essentially a review of existing studies, the details of the second and third components of the research methodology are presented as follows.

### 2.1. Survey of firms

#### *Scope of the survey*

In order to provide a broad view of firm perception of UILs the scope of the survey covered the major manufacturing subsectors in Nigeria. These include food, beverages and tobacco; chemical and allied products; pharmaceuticals; rubber and plastics products; paper, printing and publishing; metal and aluminum products; textiles and garments products; wood products and furniture; non-metallic mineral products; and electrical and electronics products.

#### *Sampling, data collection and sources*

There is currently no reliable data on firms' distribution in Nigeria, hence stratified sample is difficult to obtain. Manufacturing firms in Nigeria are known to exist in three major industrial clustering axes, namely:

- cluster 1: Lagos-Agbara-Ota-Ibadan-Ilorin
- cluster 2: Nnewi-Aba-Port Harcourt
- cluster 3: Kano-Kaduna-Jos

Cluster 1 has at least 60% of Nigerian firms in number and value addition (Lubeck, 1992; LASEPA, 1999). Nigeria is a relatively expansive country covering an area of 924,000 sq. km. The three industrial clustering axes are geographically dispersed. To ensure good quality data collection within the limits of available resources for the study we selected cluster 1 for the study. Besides, the location of more than half of the firms in cluster 1

<sup>1</sup> A similar survey had been used in the state of Minas Gerais, Brazil (Albuquerque *et al* 2005). The questionnaire instrument used for the Brazillian survey was an adaptation of that used for a survey undertaken at Yale (Klevorick *et al* 1995) and Carnegie Mellon (Cohen *et al* 2002). The questionnaire was further revised to suit the Nigerian context in order to ensure comparability, both within Africa and between the three developing regions that are involved in the IDRC RoKS project.

suggests that the survey would have significantly captured and gathered information from a sample of the larger section of the Nigerian manufacturing firms.

The lists of establishments engaged in manufacturing activities in cluster 1 were collected from the State offices of the National Bureau of Statistics (NBS) located in cluster 1. These states included Lagos, Ogun, Oyo, Ondo, Osun, and Kwara states. Though the lists are fairly comprehensive (except for Lagos State) and all have addresses of the locations of firms, they are not precise on key information required for selecting a stratified sample. The format for the lists is not uniform and not all has the required information on type of manufacturing and firm size. Based on perceived industrial concentration in each of the states 220 firms were selected for questionnaire lodgement as follows: Lagos -100; Ogun -40; Oyo -20; Ondo -20; Osun -20; Kwara -20. For each state, the sample selection was random, but guided by the perceived firm size and sub-sectoral distribution of firms in each state.

Enumerators were recruited and trained for the firm survey. When a firm originally included in the survey sample could not be located or was non-responsive to the survey, such a firm was replaced with a firm of similar characteristics in the same sub-sector. At the end of the survey, we had 153 questionnaires retrieved out of which 14 were rejected because of inadequate responses. Thus the final research sample comprises of 139 firms.

#### *Data analysis*

Data analysis carried out is largely descriptive, using measures of central tendency. For the variables that assessed the respondents' perception on a likert scale of 1 ("not important") to 4 ("very important"), the degree of importance of each factor is analyzed using the weighted average index (WAI). For the computation of WAI, 4 is assigned to the highest level of perception on the likert scale while 1 is assigned to the lowest level. In effect, if for a particular factor all respondents claim the highest degree of importance (i.e. "very important"), then the WAI would be 4.0 while the same would be 1.0 if all respondents claim the lowest degree of importance (i.e. "not important"). The weighted average index is expressed as:

$$WAI = \frac{\sum_{i=1}^4 F_i W_i}{N}$$

where

$F_i$  is the frequency of response;

$W_i$  is the weight or number assigned to the response on the likert scale; and

$N$  is the total number of responses.

## **2.2. Case studies of university practice**

As the starting point of the case studies of university practice, formats and schedules for the collection of data/information on the current state of research on agro-food processing

in the three selected universities were designed for the African regional study. We used these research instruments with modifications as appropriate for the Nigerian context. The Head of Department (HOD) of Food Science and Technology at each of the universities was the focal point and lead informant that served as facilitator of interviews and data collection in the university. We focused mainly on research activities within the last three years to minimize problem of memory re-call, and we interviewed the key researchers and stakeholders involved in specific researches that either have linkage with industry or present indications of possibility of UIL. Where UILs are identified, they are treated as the unit of analysis; and 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 UIL. Data and information on the university research mission, vision, and structures supporting research were also collected along side 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. Almost in 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 is in process, most of the respondents became enthusiastic and provided useful data/information. The only exception to this is the firms identified for the UIL cases. Compared to the university officials, the firms were reluctant to provide information by interview.

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 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 and established within the last seven 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 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 study was restricted to universities in Southwest Nigeria (akin to the firm survey). Since the sectoral focus of the study is agro-food processing, we selected three out of the eight Southwest universities that have department of food science and technology. The three universities selected comprise two specialized universities and one non-specialized university.<sup>2</sup> The common feature of the selected three universities is that they have relatively well established departments of food science and technology 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); and
- iii) University of Ibadan, Ibadan (UI).

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<sup>2</sup> 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.

In effect, the case studies focused on one university of agriculture, one university of technology, and one non-specialized university.

### 3. POLICY MECHANISMS AND THE NATIONAL SYSTEM OF INNOVATION

#### 3.1. Trends in the macroeconomic policy context

The macroeconomic policy context that underpins the National System of Innovation (NSI) in Nigeria can be divided into five distinct periods marked by significant shifts in economic policy management. These periods are:

- immediate post-independence period starting from independence in 1960 to the advent of the first military regime in 1966;
- post civil war oil economy starting from the end of the 30 months civil war in 1970 to the handover of government by the military to civilians in 1979;
- transition to austere economy that emerged in the second republic and resulted in the adoption of World Bank/IMF led economic structural adjustment programme (SAP) in 1986;
- the era of SAP and guided economic liberalization starting from 1986 to the advent of the new democratic dispensation in 1999; and
- the regime of further economic liberalization starting from 1999 and resulting in emergent macroeconomic stability in recent years.

Table 1 presents key economic performance indicators at the beginning and end of these periods. The macroeconomic policy in Nigeria has not put the evolution of the NSI in focus as a strategic objective of economic policy. For the most part in the policy process the importance of technological innovation as the engine of growth was neglected, and the performance of key economic indicators has been rather poor. From 1960 to 2005 real GDP has increased only approximately by five fold from US\$12.8 billion to US\$60.4 billion; while real GDP per capita improved marginally from US\$314 in 1960 to US\$459 in 2005. Value addition in agriculture as per cent of GDP declined over the years from about 64% in 1960 to 23% in 2005. Manufacturing value-added as per cent of GDP remained considerably low at less than 10% over the years while the share of services contribution to the GDP has been considerably high (between 19.9% and 45%) in the selected years. The relatively consistently high share of the services sector can be explained by the large informal sector in the Nigerian economy. Most economic activities of the informal sector are known to be in the domain of services. Furthermore, the share of manufacturing in total merchandise exports has been very low with the lowest of 0.02% in 1986, and an emergent improvement to 2.07% in 2003. Moreover, table 2 demonstrates that the growth rates of the economy have been unimpressive. In particular, the decade of the 1980s was a period of manifest de-industrialization indicated by negative average growth rate of industry. Much of the growth in earlier decades (1960s and 1970s) was not associated with structural change but was rather concentrated in the consumer goods sector, service industries, and assembly-type operations. The highest industrial incentives were reserved for import-substituting consumer industries with low value added and assembly plants based on imported raw materials. It was noted that the



use of local raw materials by industries was discriminated against and incentive to develop exports was practically non-existent. The fastest pseudo-growth occurred in textiles, vehicle assembly, soap and detergent, soft drinks, pharmaceuticals, beer, paints, and building materials.

**Table 1. Nigeria: key economic performance indicators**

Key economic performance indicator	1960	1966	1970	1979	1986	1999	2005
GDP in current US\$ (billion)	4.2	6.37	12.5	47.3	20.2	34.8	99.0
GDP in const. 2000 US\$ (billion)	12.8	15.3	19.8	30.2	27.6	43.6	60.4
GDP growth rate	n.a	-4.3	25.0	6.8	2.5	1.1	6.9
GDP per Capita in const. 2000 US\$	314	326	382	454	342	380	459
GDP per Capita growth rate	n.a	-6.5	22.0	3.6	-0.3	-1.3	4.7
No. of tractors per 100 ha of arable land cultivated	n.a	0.48	1.09	2.99	6.94	10.64	n.a
Manufacturing value-added (as % of GDP)	3.8	5.4	3.7	8.8	8.7	4.9	n.a
Share of manufactures in total merch. exports (%)	n.a	1.27	0.72	0.46	0.02	0.60	2.07*
Share of manufactures in total merchandise imports (%)	n.a	83.0	83.1	77.4	79.6	66.6	66.3*
Manufacturing, value added (annual % growth)	n.a	70.6	27.9	46.9	-3.9	2.1	n.a
Agriculture, value added (% of GDP)	63.9	54.9	41.3	28.7	38.7	36.6	n.a
Agriculture, value added (annual % growth)	n.a	-7.0	17.5	-3.0	9.2	5.2	8.2
Services, value added (% of GDP)	28.5	32.7	45.0	33.5	35.3	28.2	n.a
Services, value added (annual % growth)	n.a.	-4.6	20.8	2.4	7.3	0.7	7.1

Source: Compiled from World Development Indicators 2007, CD ROM

Notes:

\* latest available data for 2003; n.a = not available

**Table 2. Growth rates of the Nigerian economy**

Sector	Average Annual Growth Rate (%)				
	1960-70	1970-80	1980-90	1990-99	2000-04
Agriculture VA	-0.4	-0.1	3.3	2.9	5.3
Industry* VA	14.7	7.3	-1.1	1.7	5.1
Manufacturing VA	9.1	5.2	-1.0	n.a.	8.8
Services VA	2.3	9.6	3.7	3.1	6.1

Total Product (GDP)	3.1	4.6	1.6	2.4	5.4
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+ The figure for industry includes manufacturing;  
*n.a.* implies not available; VA = value added.

Source: World Development Report (2002-05), World Development Indicators (2001-06).

### 3.2. Innovation-deficit character of the macroeconomic policy regimes

From the foregoing, it is apparent that macroeconomic policy regime and management in Nigeria is deficient in identifying and harnessing technological innovation as engine of economic growth and development. Investment in knowledge development has been limited. Ekundare (1973) reported that a main feature of economic development policy after independence was the establishment of three new universities to boost the production of local manpower mainly for bureaucratic management, and to some extent, participation in the private sector economy. The oil boom era also witnessed the deepening and expansion of production of knowledge for development in Nigerian universities. However, macroeconomic policy management was then rudimentary and could not articulate a role for innovation policy. Science, technology and innovation (STI) were considered exogenous to Nigeria's economic development and could only be acquired from outside by means of technology transfer. The mechanisms for technology transfer were also designed mostly by outside agents that claimed to understand the technological requirements of developing countries.

The economic recession of the post oil boom made further investment in building knowledge and technological resources difficult. Besides, there was no period when reference was made to building a national system of innovation as an objective of macroeconomic policy. This is in contrast to newly industrializing countries where building capacity for science, technology and innovation (STI) was an important feature of economic development policy in their defining periods of growth. As demonstrated by Oyeyinka (2006) failure to build STI capabilities has resulted in Nigeria's current economic lag behind newly industrializing countries of Southeast Asia that were at relatively similar levels of per capita income with Nigeria in the early 1960s.

In recent times, the guided deregulation policy regime of the late 1990s, and the subsequent more elaborate and widely accepted National Economic Empowerment and Development Strategy (NEEDS) also neglected technological innovation as a major requirement for economic growth and competitiveness. It is only at the preparation of the second phase of NEEDS in 2007 that science, technology and innovation (STI) were clearly introduced in the economic reform framework as a cross-cutting issue to be promoted in order to achieve economic development objectives (NPC, 2007). It is nonetheless yet to be seen how this emerging recognition of STI would be advanced to ensure that building innovation capability is actively encouraged and supported in every sector of the Nigerian economy.

An important determinant of building STI capacity is the ability to put in place mechanisms to ensure indigenous technologies become integrated with modern

technologies to boost productivity in the industrial sector. Two major perspectives have emerged in literature in the attempt to provide a conceptual definition for indigenous technology. The first alludes to indigenous technology as homegrown and traditional technologies, while the second perspective observes the improvement of traditional technologies to fit within the requirements of a modern industrial sector. The latter perspective follows a framework that uses the 'old' and the 'new' in a complementary manner and regards the resulting nexus as innovation that is taking place within the national system of innovation (NSI). (Okigbo, 1996; Maduemezia, 1996). The importance of indigenous technologies in any country cannot therefore be over-emphasized as it is a necessary precondition for building technological capabilities and for sustaining domestic efforts aimed at effectively adapting and utilizing imported technology. Furthermore, successful industrial development lies in the ability to utilize available technologies, equipment and facilities effectively and efficiently. It involves improvement in productivity over time and the ability to diversify and increase capacity, as well as build more efficient capabilities.

At a meeting<sup>3</sup> of experts held in Nigeria on the promotion of indigenous technology for development in Africa, a working definition for indigenous technology emerged as follows:

"Indigenous Technologies consists of all the skills, techniques or know-how that are traditional/homegrown or generated in any given location, community, country or region. It may be regarded as a component of the indigenous culture or tradition, and belief in a particular locality. Most indigenous or traditional technologies were generated, invented, or evolved by trial and error or intuition over long periods of time."

Specific examples of indigenous technologies on which modern industries could be based in Nigeria exist in agriculture, medicine and capital goods sectors of the economy. For example, indigenous techniques for brewing alcoholic beverages such as whiskey and gin still provide the baseline for the numerous improvements that science and technology now provide for increase in quality and quantum of output. The brewery industry in Nigeria was successful in the utilization of local input resources (raw materials, technology, equipment and labor), to boost production activities in the late 1980s. Sorghum malt, a local and indigenous raw material, was used as an alternative to barley wheat, which was being imported. Subsequently, the machinery and equipment had to be adjusted to use the local input materials. The macroeconomic policy context in Nigeria did not provide for the sustainability of this integration of indigenous knowledge into modern technology. Consequently, by the late 1990s, the liberal economic atmosphere facilitated policy reversal resulting in the return to the use of imported barley wheat in many brewing plants.

In spite of the failure to make innovation policy an important aspect of the macroeconomic policy, there have been attempts by an array of institutions to promote technological upgrading and the integration of indigenous and foreign technologies. These institutions include science and engineering faculties in universities, specialized

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<sup>3</sup> Meeting of OAU/STRC Inter-African Committee on Science and Technology for Development held at IITA, 26-30 August 1996.

universities of agriculture and technology, publicly owned research and development institutes, polytechnics, the Raw Materials Research and Development Council (RMRDC), National Biotechnology Development Agency (NABDA), and the National Agency for Science and Engineering Infrastructure (NASENI).

### 3.3. Research and development activities

The actualization of a broad range of research activities in Nigeria started with the establishment of the Nigeria Council of Science and Technology (NCST) in 1970. The powers and mandate of the NCST covered agricultural sciences, experimental sciences, engineering and technology, medical sciences, environmental and social sciences. Specifically NCST had to oversee and manage research and development activities across ministerial lines, with four sectoral councils comprising:

- The Agricultural Research Council of Nigeria (ARCN), established in 1971;
- The Medical Research Council of Nigeria (MRCN), established in 1972;
- The Industrial Research Council of Nigeria (IRCN), established in 1972; and
- The Natural Sciences Research Council of Nigeria (NSRCN), established in 1973.

The primary function of each of this council was to fund and coordinate R&D efforts in the respective sectors. In 1977, the NCST and its sectoral councils were abolished and replaced with the National Science and Technology Development Agency (NSTDA). The NSTDA functioned until 1979 when it was dissolved and replaced with a Federal Ministry of Science and Technology (FMST). In 1984, the FMST was merged with the Ministry of Education. The name and character of this apex structure was later changed resulting in the re-establishment of the FMST in the late 1980s. Most of the public R&D institutes in Nigeria are clustered as parastatals under the FMST.<sup>4</sup> In very broad terms, the mandate and activities of these institutions can be summarized as follows:

- i) To conduct research in order to promote the utilization of natural resources appropriate to the economic conditions, environment, health and welfare of the people.
- ii) To improve productivity by propagating the results of research to benefit the country in sectors such as agriculture, industry and commerce, and health.
- iii) To train and upgrade the skills of researchers in these institutions.

As reported by Idachaba (2006), institutional instability, declining funding, emigrations of highly skilled researchers, and general uncertainty have characterized R&D activities in Nigeria in the last 25 years. After a few years of growth in the early 1970s, total spending for R&D activities fell by two-thirds starting from the mid-1970s. Consequently, R&D institutions in Nigeria have therefore performed below expectation in terms of the degree of expected support to industry or initiation of new production outfits (Igwe and Okpala 1981; Bamiro, 1994).

<sup>4</sup> As at 2004, Nigeria had over 66 public research institutes.

### 3.4. Educational system, science-orientation and human resource requirements

Table 3 provides data on the number of tertiary educational institutions in Nigeria and the period of their establishment. Since independence in 1960 the Nigerian higher educational system, especially the universities, has grown in number and the diversity of training programmes that contributed skills required for Nigeria's development. Besides, according to NMB (2005), student enrolment in the universities increased from 1,395 in 1960 to 195,759 in 1990/91 and moved up to 723,213 in 2004/05. As shown in table 4, similar trends of increase in enrolments were recorded for the polytechnic and colleges of education. As indicated in table 5, it is noteworthy for the universities that the ratio of enrolment in science-related disciplines increased from 45% in 1998/1999 to about 50% in 2004/2005 while enrolment in arts and humanities decreased from 55% in 1998/1999 to about 50% in 2004/2005. This may be explained by the relatively more effective implementation of education policy under the reform programme of the new democratic government that came to power in 1999. It is also important to note that while enrolment in the sciences appears to be improving (see table 6 for comparison of 2001/2002 with 2004/2005 sessions) there is no improvement in the proportion of engineering enrolment. Thus, the supply constraints of the core skills requirement by industry are yet to be significantly addressed by the university enrolment. There have also been more advocacies for science education at the lower levels of education resulting in enrolment being more science-oriented at the university level.

**Table 3. No of tertiary educational institutions and period of establishment**

Period	No of tertiary institutions established			
	Universities	Polytechnics	Colleges of education	Total
1960- 1970	6	5	4	15
1971- 1980	10	10	12	32
1981- 1985	7	15	14	36
1986- 1998	13	17	20	50
1999- 2007	45	28	20	93
Total	81	75	70	226

Source: NUC, NBTE<sup>5</sup> and NCCE<sup>6</sup> Annual Reports

**Table 4. Distribution of students' enrolment by type of institution**

Type of Institutions	Enrolment					
	1987/88	1990/91	1994/95	1998/99	2004/05	% increase 1987/88-2004/05
University	158,758	195,780	256,780	319,914	723,213	418.53
Polytechnic	72,134	106,926	187,738	219,770	323,684	348.73
College of Education	61,890	85,574	95,502	105,416	331,396	435.46

<sup>5</sup> National Board of Technical Education.

<sup>6</sup> National Commission on Colleges of Education.

Source: National Manpower Board, 2005

**Table 5. Distribution of university students by field of study**

Field of Study	1998/99	1999/2000	2000/01	2001/02	2002/03	2003/04	2004/05
Science (Pure and Applied)	177,631 (45.1)	182,140	189,550	243,597	315,902	343,639	358,714 (49.6)
Arts and Management Studies	216,229 (54.9)	216,416	218,962	276,800	342,227	365,393	364,499 (50.4)
<b>Total</b>	<b>393,860</b> <b>(100%)</b>	<b>398,556</b>	<b>408,512</b>	<b>519,397</b>	<b>658,129</b>	<b>709,032</b>	<b>723,213</b> <b>(100%)</b>

Source: National Manpower Board, 2005

**Table 6. Distribution of students' enrolment by field of study**

Field of Study	2001/ 2002		2004/2005	
	No	%	No	%
Science(Pure)	66,383	15.9	72,387	16.1
Medicine	30,478	7.3	34,170	7.6
Pharmacy	7,098	1.7	8,542	1.9
<b>Engineering</b>	<b>38,828</b>	<b>9.3</b>	<b>41,814</b>	<b>9.3</b>
Environmental	16,283	3.9	17,535	3.9
Agriculture	28,390	6.8	31,473	7.0
Veterinary	3,858	0.9	4,496	1.0
Education Science	23,798	5.7	26,077	5.8
<b>Total</b>	<b>215,016</b>	<b>51.5</b>	<b>236,497</b>	<b>52.6</b>

Source: National Manpower Board, 2005

### 3.5. Capacity for innovation in firm and industry structure

In the 1960s and 1970s the popular view in Nigeria was that large scale enterprises were the cornerstone of industrialization. Many of these large firms were owned by foreign investors and multinationals. The government at various levels (Local, State and Federal) also owned firms (solely or in partnerships), with the aim of stimulating industrial growth. However, in line with on-going reforms in Nigeria, there has been a significant move to privatize government owned firms, such that government's role in the industrial sector will become limited to that of an enabler or facilitator by implementation of policy initiatives that allow the private sector to take the lead role, particularly in manufacturing activities (NPC, 2007). Development of small and medium-sized enterprises (SMEs) has also been accorded significance under the current economic reform because it engenders the development of local industries, the generation of employment and income, and the extension of industrial production over a greatly diversified base. The development of SMEs is linked to priority projects, which include those that can create forward and backward linkages with the rest of the economy; promotion of export-oriented industries

that utilizes large volume of local raw materials; and adoption of technologies that significantly improve performance. This notwithstanding, a high proportion of SMEs in Nigeria still lack the necessary support mechanisms for improving innovation capacity and promotion of industrial competitiveness. Oyeyinka et al (1995) identified some of the constraints on the innovation capacity of SMEs in Nigeria as follows:

- low technological capacity of SME support institution;
- poor infrastructure especially in the area of electric power;
- low skills intensity;
- poor management of resources;
- strong links between domestic enterprises and foreign parents which prevent backward linkages and patronage of local research institutes;
- lack of significant capital goods sector; and
- local research institutes that should support the technical change process in SMEs are grossly under-funded.

The profile of industrial firms in Nigeria is characterized by high level of imported plants and machinery and a weak science and technological infrastructure in form of requisite human capital, as well as capability for adoption, adaptation and assimilation of imported technologies. Table 7 gives the structure of capital goods and machinery and equipment importation in Nigeria between 2000 and 2004. The table confirms that the bulk of the demand for capital goods by Nigerian firms as well as the supply of machinery and equipment has been met through imports for many years. Also, the ratio of capital goods importation to consumer goods had remained almost stagnant at about 1 to 2 for almost five consecutive years. This scenario demonstrates the fact that capital goods importation of iron and steel products, for example, which are supposed to serve as catalyst for the local production of consumer durable goods continue to lag behind imported manufactured consumer goods.

**Table 7. Structure of imports of capital goods (2000-2004)**

	2000	2001	2002	2003	2004
Ratio of Capital Good to Consumer Goods	1:1.8	1:1.8	1:1.9	1:1.9	1:2
Ratio of Capital Goods to Total Imports	1:5	1:4.7	1:4.8	1:1.7	1:4
Ratio of Consumer Goods to Total Imports	1:2.6	1:3.0	1:2.6	1:2.5	1:2
Ratio of Machinery & Equipment to Total Import	1:4.2	1:4.2	1:4.2	1:4.2	1:4

Source: Derived from Central Bank of Nigeria Annual Report, 2003.

The weakness of the capital goods industry continues to hinder the development of the manufacturing activities in Nigeria. Critical firms that can stimulate radical change in the industrial landscape have been unable to perform in spite of huge public sector investments in them. For example, the main petrochemical complex located in Warri is yet to make significant impact on the economy. Besides, attempts to revive the Ajaokuta Steel Complex and the Delta Steel Plant through privatization are still in progress. In particular, the stunted and uninspiring growth of the steel industry, and the comatose

machine tool industry have truncated the development of the capital goods industry.

Table 8 shows the investment profile for the industrial sector for the period, 2001 to June 2003. Investment in R&D activities has always and continues to account for very low share of total investment. For example, investment in R&D accounted for only 1.4 per cent, while plant and machinery accounted for about 59.3 per cent of investment within the period of consideration. In the agro-food processing sub-sector represented by food & beverages, only 0.3% of investment was in R&D. Also, of the total investment in the iron and steel sub-sector, R&D accounted for only 0.2 per cent while in the electrical and electronics and motor vehicle sub-sectors, R&D accounted for only 0.5 per cent and 5.8 per cent of investment respectively. The low level of investment in R&D explains in part why the level of innovation has been disappointingly low. The relatively high level of investment in plant & machinery and equipment, as reflected in almost all the sub-sectors, is an indication that the capacity to produce technology in Nigeria did not improve during the period as the bulk of these investments are in new plants and replacement of aged production equipment which are mainly sourced through imports.

**Table 8. Investment by sector and type, 2001-2003 (₦ million)**

Sector	Land & Building	Plant & Machinery	Equipment	Spare Parts	R&D	Vehicle	Others	Total	Sectoral %
Food, Beverage & Tobacco	1,490.8	4,623.0	648.2	610.8	29.9	1,513.3	281.7	9,197.7	26.8
Textiles, Apparel Footwear	326.6	437.8	12.14	2.54	14.5	9.32	0	802.8	2.3
Wood and Wood Products	39.8	22.0	2.2	53.2	1.45	2.5	0	121.2	0.3
Pulp & Paper Products	5.0	644.5	5.0	55.6	0	9.7	0	719.8	2.1
Chemicals & Pharmaceuticals	1,540.0	7,545.6	747.0	444.7	140.0	356.3	72.9	10,846.5	31.6
Non-metallic & Mineral Products	110.3	519.0	96.0	16.4	13.69	11.1	0	766.5	2.2
Domestic & Industrial Plastic	511.7	575.4	8.9	19.2	6.2	25.0	0.93	1,147.3	3.3
Electrical & Electronics	2.5	452.3	0	0.3	2.2	9.3	0.7	467.3	1.4
Basic Metal, Iron & Steel	755.6	4,353.4	33.0	231.2	12.3	239.5	239.7	5,864.7	17.0
Motor Vehicle & Miscellaneous Assembly	999.4	1,209.8	939.9	131.6	257.5	866.9	0	4,405.1	12.8
<b>TOTAL</b>	<b>5,781.7</b>	<b>20,382.8</b>	<b>2,492.3</b>	<b>1,565.5</b>	<b>477.7</b>	<b>3,042.9</b>	<b>595.9</b>	<b>34,338.8</b>	<b>100</b>
<b>% of Total</b>	<b>16.8</b>	<b>59.3</b>	<b>7.3</b>	<b>4.6</b>	<b>1.4</b>	<b>8.9</b>	<b>1.7</b>	<b>-</b>	<b>100</b>

Source: Derived from MAN's Economic Review, 2002 and Annual Report and Accounts, 2003



Having presented an overview of the policy mechanisms that determine economic and technological context of knowledge intensification in Nigeria's agro-food processing, the following section examines the features of constraints on university-firm interaction both from the perspectives of firms and university practice in Nigeria.

#### 4. FEATURES OF THE CONSTRAINTS ON UNIVERSITY-FIRM INTERACTION

##### 4.1. Conditions in the Firm that Constrain University-Firm Interaction

Results of the survey of firms demonstrated that conditions in the firm that constrain university-firm interaction can be broadly classified into two: firm's limited R&D capability, and firm's low perception of the quality of knowledge from the universities.

##### 4.1.1. Limited R&D capability

From the findings of the firm survey, there are ample evidence of limited firm level R&D capability among the sample firms. Innovation is mainly in products that are only new to Nigeria. Table 9 presents the nature of the new or improved products and processes introduced by the research sample firms in the last three years prior to the survey. Except for the case of the introduction of products or processes that are new for Nigeria but not new for the world, the trend in the product and process changes is fairly similar. Product or process changes that are new to the world are rare among the sampled firms. It is apparent from the results that introduction of "products that are new for Nigeria, but not new to the world" is more common than the introduction of "processes that are new for Nigeria, but not new for the world". Another evidence of limited R&D capability is low investment in R&D. Table 10 shows the distribution of the estimated percent of annual sales turnover invested in R&D "in-house" by the sampled firms. The mean estimated percent invested is only 1.65%, while the median is 0.8%. 41.2% of the respondents have no R&D investment in the past three years prior to the survey while only about 5% of the respondents invested more than 5% of sales turnover in R&D. In fact only one firm indicated the highest estimated investment of 11% while three firms indicated an estimated investment of 10%. Furthermore, most R&D by firms are occasional and non-formalized; and only 30% of the sample firms claimed to have R&D department.

**Table 9. Nature of new or improved products and processes**

Nature of innovation	Percent of respondents	
	Product*	Process*
No new product or process	18.1	15.1
Improvement on existing product or process	74.1	77.0
New for firm, but not new for country	23.7	23.7
New for country, but not new for the world	15.8	8.6
New for the world	2.2	2.2

\* the sum of this column is not equal to 100 because each response may have more than one option as the nature of the product or process introduced

Source: Analysis of field data

**Table 10. Distribution of in-house R&D investment as percent of annual turnover**

Percent of annual turnover invested in R&D	Percent of respondents
0	41.2
0 – 1.00	19.3
1.01 – 2.00	14.1
2.01 – 3.00	7.0
3.01 – 4.00	1.7
4.01 – 5.00	11.4
> 5.00	5.3
<b>Total</b>	<b>100</b>
<b>N</b>	<b>114</b>
<b>Mean</b>	<b>1.65</b>
<b>Median</b>	<b>0.8</b>

Source: Analysis of field data

#### *Reasons for not investing in R&D*

Table 11 presents the results of firms' perception of reasons for not investing in R&D. The reasons were rated on a four-level likert scale spanning 1 (for "not important") to 4 (for "very important"). The weighted average index of the responses demonstrate that the importance of universities are rated very low as locations of substitute R&D that could serve as reasons for lack of firms' in-house R&D. As indicated by the weighted average index, the three most crucial reasons (in order of perceived importance) for lack of investment in R&D by firms are sufficiency of external sources of information for innovation, lack of access to credit, and high cost of R&D. Other reasons that are considered more than "slightly important" by firms are "R&D is not necessary for the firm's innovation" and "R&D investment is too risky". It appears from these results that firms depend on external sources of knowledge and have the notion that firm-level R&D is not necessary for innovation. Firms have little or no resources to invest in R&D, and hence R&D is considered too risky and expensive.

**Table 11. Firms' perception of reasons for not investing in R&D**

Reason for not investing in R&D	Weighted average index
The firm does not innovate	1.8
Small market size disallow recovery of R&D invest.	1.9
R&D investment is too risky	2.1
R&D is too costly for the firm	2.3
Lack of access to credit	2.4
Difficulties to appropriate R&D results	1.8
Lack of public support	1.8

R&D is not necessary for the firm's innovation	2.2
External sources of info are sufficient for innovation	2.6
Universities substitute firm's R&D	1.4

Source: Analysis of field data

#### 4.1.2. Low perception of the quality of knowledge from the universities

There are several sources of information and knowledge that contributes to firm's innovative activities. Firms were provided with a list of various sources of information and knowledge, and they were requested to indicate which of the sources had benefited the firm's innovative activities, in terms of suggestion of new projects or contribution to the completion of existing projects in the last three years. It was discovered that the three leading sources of information and knowledge for the suggestion of new projects are also the three leading sources of information and knowledge that contributed to the completion of existing innovative projects. These three leading sources are customers, firms' manufacturing operations, and affiliated suppliers (suppliers linked through ownership such as parent, sister or subsidiary firm). Universities took the least position in the perception of firms as a source of information and knowledge that had resulted in the suggestion of new projects and as sources of knowledge that contributed to the completion of existing projects. In fact, none of the firms considered universities as most important source for information for completing existing innovation projects.

##### *Why universities are not important sources of information for innovation*

The responses given by the sampled firms on why universities are not important sources of information for innovation were rated on a four-level Likert scale spanning 1 ("not important") to 4 ("very important"). Table 12 presents the results of the weighted average index analysis of the responses. The two reasons with the highest WAI of 2.3 suggest that universities are not rated as important sources of information for innovation because firm's R&D are considered enough to innovate and the quality of research in universities are considered low. Added to this, reasons that are perceived by the respondents as more than "slightly important" as indicated by the WAI of 2.2 include the lack of understanding of firms' line of business by universities, and universities' focus on big science. Other reasons mentioned in table 12 have WAI less than 2.0, suggesting that they are generally perceived by the sampled firms to be less than "slightly important" as explanations for why universities are not important sources of information for innovation. In effect, the distribution of the responses showed that most of the respondents claimed the reasons listed in table 12 to be either "not important" or "slightly important".

**Table 12. Reasons why universities are not important sources of information**

Reasons	Per cent of respondents				WAI
	1	2	3	4	

Our firm's R & D is enough to innovate	42.9	12.1	20.9	24.2	2.3
Universities have no understanding of our line of business	39.4	24.5	16.0	20.2	2.2
Contractual agreement difficult	49.5	25.3	11.0	14.3	1.9
Lack of trust	54.9	22.0	7.7	15.4	1.8
Quality of research is low	38.3	21.3	13.8	26.6	2.3
University concerned with only big science	46.7	12.0	18.5	22.8	2.2
Geographic distance	65.2	12.0	7.9	9.0	1.6
Dialogue is very difficult	62.2	14.4	15.6	7.8	1.7
Intellectual property issues	53.8	16.5	18.7	11.0	1.9

Source: Analysis of field data

Table 13 presents the results of the weighted average index analysis of firms' rating of the importance of channels of information and modes of interactions with the research activities or research findings of universities. The results demonstrate that the importance of "publications and reports" and "public conferences and meetings" have the highest ratings as channels of information on universities research findings with WAI of 2.7 and 2.6 respectively. Other channels of information viewed by the respondents as important and having WAI of at least 2.0 include licensed technology, informal information exchange, recently hired graduates with advanced degree, patents, and consulting with individual researchers with WAI of 2.3, 2.1, 2.1, 2.0 and 2.0 respectively. University ownership of firms or spin-offs were considered least important as channels of information by the respondents firms. Incubators were also considered to have very low importance as channels of information by the respondent firms. Overall, the results in table 13 demonstrate that arms length relationships predominate between firms and university research.

**Table 13. Channels of information and modes of interaction with the research activities of universities**

Channels of information/ Modes of interactions	Weighted average index
Patents	2.0
Publications and reports	2.7
Public conferences and meetings	2.6
Informal information exchange	2.1
Recently hired graduates with advanced degree	2.1
Licensed technology	2.3
Consulting with individual researchers	2.0
Contract research with universities	1.7

Joint or cooperative R&D projects	1.6
Participation in networks that involve universities	1.6
Temporary personnel exchanges	1.6
Incubators	1.4
Science and/or technology parks	1.9
Firm is owned by an university	1.3
Firm is a spin-off of an university	1.3

Source: Analysis of field data.

#### 4.2. Conditions in the university that constrain university-firm interaction

As earlier indicated, the investigation of the conditions that constrain university-firm interaction in the case study universities focused on knowledge intensification in the agro-food processing. While the results of the firm survey provide a relatively broad overview of firm perception, the focus on agro-food processing enabled the university case studies demonstrate a more penetrating insight from the perception of the universities. Before discussing the constraints on university-firm interaction from the perspectives of universities it is therefore necessary to briefly review the state of agro-food processing research in each of the three universities.

##### *Agro-food research at the University of Agriculture*

Research in agro-food processing at the University of Agriculture was one of the oldest in the university. Its focus is on post-harvest technologies and food processing, and the research findings 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. Research specializations include tuber crop utilization, composite flour technology, equipment design and fabrication, legume processing, food quality and assurance, and microbiology and biology. A biotechnology centre (established in 2001) also exists for carrying out biotechnology research and coordinating all biotechnology-related research and training activities in the university. Some of these research units have become multi-disciplinary in nature and had attracted international funding and interactions. The university also has a Research and Development Centre (RESDEC) established in 1990 and an Agricultural Media Resources and Extension Centre (AMREC) established in 1991. RESDEC organizes, fund and monitor research activities in the university; while AMREC acts as the outreach and extension agency of the university research. The university 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 university's department of food science and technology (DFST) presented in table 14.

**Table 14. Research outputs of the university of agriculture's DFST**

Research unit	Research projects	Commercialized?	UIL case?
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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 dryer 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 "roko", "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

#### *Agro-food research at the University of Technology*

From the data obtained from the interviews, research into agro-food processing at the University of Technology appears not to be as elaborate as that of the University of Agriculture. This notwithstanding, research into the agro-food processing sector has been one of the main research concern of the university. There is evidence that agro-food processing research is concentrated on post-harvest technologies. Examples are in the processing and storage of farm crops with reference to grains and tuber sponsored by one of Nigeria's major banking institutions. 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 colossal wastage of efforts in terms of money, materials and labour on land preparation to planting and harvesting of such crops. Specific achievements in research into post harvest technologies at the university include the design and fabrication of solar dryer for small scale farmers; design and fabrication of de-stoning machine for grains; design and fabrication of maize de-husking machine; and waxing effects on physical and biochemical characteristics of orange. Though none of these research outputs has been in commercial application, it is however noteworthy that the university has a Center for Research and Development (GERAD) which was established in 2003 with promotion of university-industry linkage as one of its main objectives.

#### *Agro-food research at the non-specialized University*

Research in agro-food processing at the non-specialized university is one of the oldest in Nigeria. The departments of Food Technology and Agricultural Engineering of the university where agro-food processing research are based are among the first set of academic programmes that focused on agro-food processing in Nigeria. In recent years,

the university has a University Mission Research (UMR) which has researched largely into agro-food processing. As at the time of this study, the UMR has delivered thirteen project reports detailing research outputs five of which has been patented by the university.<sup>7</sup> Twelve technologies that can be commercialized have emerged and some of these include:

- 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 developed by three departments from three different faculties and to some extent employed biotechnology).
- Design and fabrication of an electrical machine for binding that will not use starch, but some waste fluid from cassava peels.
- Design and fabrication of waste paper re-cycling machine for cottage industries.

In addition to the agro-food processing research projects identified under the UMR programme, other important agro-food processing research that has taken place within the last three years include: application of solar energy in drying and cooking; application of imaging for quality inspection; determination of engineering properties of food crops; design and fabrication of oil expellers with particular focus on beni-seed (i.e. sesame seed); improvement of palm kernel oil expression using crude press; and formulation of the agricultural properties of pine-apple concentrates into powdered form without any additives.

From the foregoing it is apparent that the state agro-food processing research in the three universities has not demonstrated evidence of ample university-firm interactions. The major question that was profoundly addressed by the case study interviews at each of the universities deal with the constraints on the interactions. From the responses obtained, the constraints enumerated can be grouped into three categories that are infrastructure-related, policy-related, and attitude-related.

#### **4.2.1. Infrastructure-related constraints**

Two key infrastructure related constraints identified by the interviewees in the three universities include poor research facilities and equipment, and poor electric power supply. Other important infrastructure constraints mentioned are inadequate laboratory or research space, poor access roads to research farms and industrial estates, lack of communication equipments in laboratories and research farms, lack of food halls to display research findings and scale-up facilities or lack of demonstrative pilot plants to help expose research findings.

##### *Poor research facilities and equipment*

<sup>7</sup> 13 research findings have actually been sent for patenting rights with five already patented.

An important feature of the immediate post-independence economy up to the era of oil boom in Nigeria is investment in universities. The faculties of agriculture, basic sciences and to some extent engineering, attracted significant investment in research infrastructure. However, the decay in research infrastructure could be associated with the advent of the austere economy in the early 1980s and the subsequent era of economic structural adjustment programme. The economic deregulation of the 1990s also could not help improve the research infrastructure of the universities and allied institutions because resources are limited, and investment in science and technology was not recognized as crucial to economic recovery. The questions raised in the course of case study interviews were aimed at ascertaining whether or not the ongoing reforms that started with the implementation of the National Economic Empowerment and Development Strategy (NEEDS) in 2003 are perceived to have engendered improvement in research infrastructure.

From the information and data obtained, only one of the three universities clearly acknowledged some improvement in research infrastructure in the last three years. According to the non-specialized university, there has been some improvement in research facilities and equipment and a central laboratory where modern scientific equipment would be clustered is presently under construction. However, the major support for the improved standing of research facilities was traced to the funding received from an international foundation since 2001. In spite of this, it was still stressed by all the interviewees that poor research facilities remain an important constraint on university's ability to form a virile linkage with industrial firms. There is currently no example of agro-food processing research using modern laboratory equipment in the university. The only example of research that uses modern equipment is the cassava flash dryer project which is domiciled in the International Institute of Tropical Agriculture (IITA). (IITA footnote). The University of Agriculture also demonstrated the constraints posed by the poor state of the research facilities and equipment. In the food science and technology department, the existing laboratories are limited in supporting research. The exception to this is biotechnology related research which may use the facilities at the biotechnology centre. This notwithstanding, the director of the biotechnology centre expressed deep sense of inadequacy of the facilities at the biotechnology centre. A vivid illustration of the inadequacy of research facilities was presented thus by one of the lecturers as follows:

"After I had the concept for my PhD, I discovered that most of the things I wanted to do cannot be done in this country due to poor research facilities. I therefore contacted a professor of food engineering in the University of Georgia, USA. The professor told me that their laboratory was available and he gave me the cost estimate of US\$5000 excluding transportation, accommodation and feeding. However, I could not afford it. I then focused on the aspect of the work I can do in Nigeria while the part that was to be done abroad was tactically removed by me. I then included more research issues based on the facilities that we have here. I did some of the work at the IITA and National Centre for Agricultural Mechanization (NCAM) in Ilorin. I also went to Moor Plantation Ibadan to carry out some of the experiments. If I had my way and means, I would have preferred to do the work abroad in the USA and would have possibly made more productive use of my research skills" (Field interview, 2008).



An interesting fall out of the poor research facilities at the University of Agriculture is the reported case of a university lecturer and some students collaborating with two major flour mills to carry out research on blending of wheat and cassava flour to comply with the government policy on 10% cassava flour in wheat flour under PICPE.<sup>8</sup> Box 1 presents the lecturer's narration on his informal collaboration with the flour mills.

**Box 1. Addressing infrastructure constraints: the case of informal collaboration with flour mills**

- Most of my research work has industrial application. My PhD which is the latest is based on an instinct obtained from the Federal Government policy - Nigerian initiative on cassava export and use of cassava for raw material for food and other industrial purposes (10% cassava policy). I set out to characterize cassava varieties in terms of their flour-making properties in order to get which is suitable for bread-making. At the end of the day, one of the products of my work is that we were able to identify the specific properties of cassava flour that can be used to screen cassava root for food uses. Thereafter, I went into formulation, trying to look at what effect formulation can have on the quality of bread because the main problem of making bread whether from cassava flour or any other flour is the problem of keeping it longer, that is, the problem of short shelf life.
- I had to do some of my research work at the IITA because they provided all the materials and financial assistance to carry out the work. I also did the work with two local flour mills where I used some of their equipment to find out the radiological properties of my dough. The contact with these firms was informal though one of our former students that now works in one of the flour mills. Formal request for contacts are usually turned down. I used their bakery to bake bread and characterize them. These flour mills have laboratories where properties of flour and dough can be tested. These labs are quality assurance labs. One of the flour mills has a sophisticated laboratory. I also sent my students to these labs and the firms allowed us to use the labs without charges. I think the motivation for these industries is that the research serves them by providing technical information that is related to their work. The most important observation that I have been able to make so far is that these firms despite the fact that they collaborate with the academia by way of allowing us to use their facilities, they show little or no interest in the outcome of our research. It appears that as long as there is no immediate commercial gain in research outcomes, the firms will show no interest.

Source: Field interview

*Poor electric power supply*

The power sector in Nigeria has apparently been in a state of crisis for many years. Attempts to rescue and reform the sector in the past eight years have yielded little results and remedy to the malady remains a mirage. Power supply in Nigeria is still grossly inadequate to meet demand. According to NISER (2008), out of the total installed capacity of about 6450MW maximum output in recent years has not exceeded 4000MW. Like other sectors of the economy, poor electric power supply were identified in each of the three universities as major constraint on university-firm interactions. There is no

<sup>8</sup> PICPE is the Presidential Initiative on Cassava Production and Export which was officially launched in 2004 to promote the diversification of the economy through industrial processing of cassava to add value and achieve significant export of cassava products (CBN, 2007; Adeniji, 2007).

guarantee of power supply to operate critical laboratory equipment. It is generally perceived by the universities that this limits the scope of research that can be carried out in the universities and makes firms to be reluctant to engage universities in research endeavours. Besides, provision of electric power by means of diesel or petrol generators has made research in the universities more risky and more expensive. In one of the universities, the situation is as bad as graduate students having to hire petrol generators to make presentations on their PhD research. At another university, almost every department has a petrol generator as alternative source of power. Besides the cost of running these generators, the noise pollution make concentration difficult for researchers and effluents from the generators lowers the air quality. For the biotechnology centre at the University of Agriculture, it was reported that lack of regular electric power supply has restricted research on sensitive enzymes; while the new central research laboratory being built at the non-conventional university has considerable fund allocated to a local power generating plant. This fund could have found alternative use in possibly additional laboratory equipment or reagents.

#### *Other infrastructure constraints*

One of the other important infrastructure constraints mentioned by the universities is inadequate laboratory or research space which is evident especially in the case of the biotechnology centre at the university of agriculture, and to some extent at the University of Technology. The complaints of laboratory space did not feature in the non-specialized university possibly because it is the oldest and had the advantage of having buildings that could house standard laboratories. Besides, the major ongoing support from an international foundation provided it with an edge above the other two universities especially with respect to the new central research laboratory under construction. Other infrastructure constraints mentioned as limiting university-firm interaction include poor access roads to research farms and industrial estates, lack of communication equipments in laboratories and research farms, lack of food halls to display research findings and scale-up facilities or demonstrative pilot plants to help expose research findings.

#### **4.2.2. Policy-related constraints**

So far there is no policy that addresses the challenge of university-firm interaction in Nigeria. The respondents in the university case studies profusely narrated the frustration associated with lack of policy on university-industry linkages. In this respect, the constraints associated with university-firms interactions as identified by the respondents include lack of incentives and poor government support for industry R&D, lack of policy to protect intellectual property of scientists, and poor funding of research.

#### *Lack of incentives for industry R&D*

Though firm survey did not provide insight on firm perception of government support for industry R&D, the university case studies revealed that evidence of government support for industry R&D is rare. None of the respondents could identify any government policy that favour industry R&D. In fact the general impression is that the policy regime provides little or no incentive for industry R&D. Consequently, it is believed that university-firm interaction cannot thrive. This is premised on the notion that the

university is part of the public research system which is ordinarily unattractive to industry. For firms to be involved with the university, an incentive regime would be necessary. A response from an interview (see Box 2) with a multinational firm involved in a UIL with the University of Agriculture aptly capture the features of policy constraints on university-firm interaction, especially the lack of incentives for industry R&D.

**Box 2. Policy 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 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 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.

**Source:** Field interview

From Box 2, other policy related issues associated with lack of incentive for industry R&D as constraint on university-firm interaction include outdated university curriculum that does not address the skill needs of industry, proliferation of taxes, and unfavourable macroeconomic environment. From the perspective of the universities, one of the researchers expressed his frustration on lack of government policy on industry R&D as follows:

“There is 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” (Field interview, 2008)

Though the view of this researcher may be contested, it underscores the inherent policy weakness and inability of existing policies to promote university-firm interactions.

*Lack of policy to protect intellectual property of scientists*

The Nigerian patent office is located in the Federal Ministry of Industry and Commerce. From the interview conducted, it appears that researchers recognize the existence of the patent office but consider the cost of patenting expensive. Two of the universities are beginning to respond to this challenge. The University of Agriculture claimed to have created a unit at RESDEC in 2008 to assist researchers with patenting. The non-specialized university also claimed to have assisted researchers under the University

Mission Research Programme (UMR) to patent some of the inventions. Though these initiatives are commendable, they nonetheless demonstrate the inherent lack of policy to encourage or protect the intellectual property of researchers. Besides, there is an indication that some of the scientists have no confidence in the security of the local patents. One of the professors of food technology interviewed preferred to keep his inventions secret. Moreover, Adeoti (2002a) also reported a similar attitude in the case of a scientist that discovered a wastewater organic digester ('*Oso biodegrader plus*') in the late 1990s.

#### *Government poor funding of research*

Researchers in the three universities have a consensus on the poor government funding of research. At the University of Agriculture, 80% of the research funds are obtained from the Federal Government. However, the director of RESDEC disclosed that this can only fund about 50% of acceptable research proposals. Proposals are often refused not for lack of quality but because there is no fund to execute them. The director of the biotechnology centre also complained of lack of fund to procure consumables and reagents as a major constraint. Though we were unable to obtain specific estimates of the level of government funding of research at the University of Technology, responses from the researchers interviewed affirm that 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. It was disclosed that the fund granted for university sponsored research is often not enough to carry out approved research proposal. Consequently, many projects have been abandoned mid-way due to insufficient funds to complete them.<sup>9</sup> Professors at the non-specialized university also reported that government fund for research has been grossly inadequate for several years in spite of the notion that the university should take the lead in postgraduate training and research.

#### **4.2.3. Attitude-related constraints**

From the results of the interviews, attitudinal issues that constrain university-firm interaction include lack of political will to address R&D challenges, entrepreneurship culture that lack support for R&D, research done mainly for publication, and divergent views emanating from the mindsets of scientists and industrialists.

#### *Lack of political will to address R&D challenges*

The university case studies underline the fact that addressing R&D challenges will require deliberate efforts aimed at tackling specific deterrents to university-firm interactions. Areas of concern identified by the professors interviewed include:

- Lack of deliberate drive by the universities and government towards commercialization of research outputs by the universities.
- Poor attitude 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 lack of good examples by government and political leadership which often patronize

<sup>9</sup> The average amount of money granted each researcher ranges from N150,000 to N300,000 according to the rank of the researcher (US\$ = N15 at the time of the study).

foreign made goods and services even when there are locally produced equivalents that offer value for money.

*Entrepreneurship culture that lack support for R&D*

Local entrepreneurship culture in Nigeria is still concentrated in investments that mature fast and yield returns in the short to medium term. However, investment in R&D has a different culture of high risk and often long term but high returns when the investment matures. One of the respondents at the University of Agriculture observed that Nigerian entrepreneurs think business, and even when they think of philanthropy or corporate social responsibility they are driven by the profit motive. The kind of support for R&D by international foundations such as being experienced by one of the universities has presently no local equivalent.

*Research done mainly for publication*

The notion from the firm survey that universities are concerned only with big science was confirmed by university researchers interviewed. In all the three universities there is a culture of "publish or perish" which drives research such that scientific inquiries are mostly done to generate academic publications required for promotion rather than being based on real life problems. One of the respondents suggested that this attitude should be replaced by a new culture of "patent, publish and flourish". It is expected that this will foster a tendency to relate with industries which will promote university-firm interaction. It is also noteworthy that two of the universities are considering embarking on mission-oriented and multidisciplinary research that focuses on specific themes that may be of interest to industry.

*Divergent mindsets of scientists and industrialists*

It was observed by the respondents that a major constraint on university-firm interaction is the divergent views or mindsets of scientists/researchers and industrialists. This often results in ego-centric attitudes on the side of industry and academics. For example one of the respondents stated that the academia believes it is superior to industry in terms of knowledge, while industrialists consider themselves better in terms of turning knowledge into money, as such do not need one another.

## 5. ILLUSTRATION OF UILs: HOW UNIVERSITY-FIRM INTERACTIONS WORK IN NIGERIA

From the analysis of the constraints on university-firm interaction presented in section four, it is apparent that UILs in agro-food processing are not common in the three case study universities. However, apart from the informal collaboration mentioned in Box 1, we identified three UILs which illustrate how UILs in agro-food processing has worked in Nigeria. The three cases can be characterized as follows: principal agent demand-driven, multi-stakeholder problem based, and arms length consultancy. We will analyze each of the UILs by explaining the initial conditions that favour the emergence of the

UIL and its objectives, the progress made on the UIL, the outcomes and future prospects of the UIL.

### 5.1. Principal agent demand-driven UIL

The UIL identified as principal agent demand-driven is the *UNAAB-Nestle Soyabean Popularization and Production Project* which has been a case of interaction between the University of Agriculture and Nestle Nigeria PLC since 1999. Nestle Nigeria PLC employs about 1800 people and soyabean is one of its major raw materials used especially for baby foods. The firm has been the only major external donor and industrial partner with UNAAB.<sup>10</sup> The principal agent in this case of UIL is Nestle and the driver of the UIL is demand for soyabean.

#### *Initial conditions and objectives*

From the interviews and data obtained on UNAAB-Nestle Soyabean Popularization Project, the initial conditions that enabled the UIL can be characterized as follows:

- In the early 1990s the managing director and chief executive officer of Nestle who was an Abeokuta Chief proposed UNAAB to help solve the problem of local sourcing of raw material such as soyabean, maize and onions. The managing director was an Abeokuta Chief who apparently would like to contribute to the development of the University of Agriculture located in his hometown. This suggests that a subtle informal interest might have played a critical role in proposing UNAAB as a partner to Nestle.
- A research collaboration between UNAAB and Nestle was initiated, and this boosted the interest of the current 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 seed 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. 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

<sup>10</sup> As an indication of the level of Nestle support for the project it was reported by AMREC (2007) that Nestle provided a grant of ₦5 million for the project in 2007.

from the lines at the IITA trial farm to ADN Ltd, Kaduna for Nestlé'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 which resulted in unacceptable high cost of producing the seeds. 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 hold the research team that 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 ways of further partnership. UNAAB told Nestle that the previous research collaboration had established that soyabean can also be grown in the Southwest Nigeria. So UNAAB started a project with Nestle on popularization of soyabean in Southwest Nigeria. Nestle had previously 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.<sup>11</sup> Though this is true, UNAAB had demonstrated that wholesome harvest of soyabean could be obtained in spite of the rains in the Southwest.

The main objective of the UIL is to stimulate sustainable interest of farmers in soybean production with a view to increase their capacity to produce seeds of industrial quality and consequently improve 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.

#### *Progress made*

The UIL is a farmer oriented project and essentially aimed at making farmers grow more soyabean that is of industrial quality.<sup>12</sup> While it helps to address the soyabean problem of

<sup>11</sup> 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.

<sup>12</sup> Nestle-UNAAB project started with a pilot scheme in the 1999/2000 planting season in two model extension villages (Ilewu Orile and Ijale Papa in Abeokuta North Local Government Area of Ogun State). All operations at the pilot stage were funded by Nestle. In 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, Eruwa, etc.) observed the success of the project in

Nestle, it is also seen as project with a component of corporate social responsibility by helping to improve farmers' livelihood and contributing to UNAAB's extension activities. However, the UIL presently has no research component because Nestle is unwilling to support research in soyabean. According to one of the professors interviewed, this may not be unconnected with the international politics in soyabean production. Even IITA has stopped research on soyabean because of USA. USA provided money for soyabean research in IITA, but USA now believes they can produce soyabean for the whole world. USA is no more supporting research on soyabean in developing countries.

The UIL 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 ₦300,000/unit) and thus its supply is free but limited to one thresher per state per annum.<sup>13</sup> The supply of thresher started in 2003. 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 project.

#### *Outcomes and future prospects*

The following outcomes of the UIL could be identified:

- Learning by interaction between UNAAB scientists and Nestle farm managers and farmers
- Cost savings for Nestle Nigeria PLC by finding alternative to the inefficient ADN Farms
- Regularly supply of high quality soyabean to Nestle by farmers in the UIL
- Boost to UNAAB's extension activities resulting in popularization of UNAAB's model of soyabean cultivation in Southwest Nigeria
- Improvement in livelihood conditions of soyabean farmers in Southwest Nigeria
- Boost in national soyabean production as Southwest Nigeria became an important soyabean growing region
- Improved technology adoption for soyabean processing, especially threshing.

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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.

<sup>13</sup> 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 ₦74,000/ton. Besides, it was becoming difficult for the project's resources to cover Ondo State due to its distance from UNAAB.



From the interviews of UNAAB and Nestle officials it appears that the UIL is established and relatively stable. The main interests of the major players are taken into consideration, namely, Nestle has secured a stable source of high quality grains, UNAAB has partners supporting its extensions activities, and farmers obtain good returns for their investments. Thus, the UIL is mutually beneficial. However, the lack of ongoing research component is a major weakness of the UIL. In spite of the international situation of soyabean research, it would still be helpful to have a local research component that may advance current achievements. Such research component may not necessarily be restricted to soyabean. It may include experimentation on local alternatives to soyabean. As it is now, it appears that the future of this UIL mainly depends on continuous relevance of soyabean as a major raw material used by Nestle.

## 5.2. Multi-stakeholder problem based UIL

The multi-stakeholder problem based UIL identified in the course of this study is the *cassava flash dryer project*. The project involved one large privately owned integrated farm (Godilogo Farm Ltd) having extensive cassava plantation and a cassava processing factory; three universities including the University of Agriculture and the non-specialized University<sup>14</sup>; the IITA; and the Raw Material Research and Development Council.

### *Initial conditions and objectives*

The initial conditions that favour the multi-stakeholders approach to the cassava flash dryer project can be itemized as follows:

- 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). Nigeria is currently the world largest producer of cassava.<sup>15</sup> The production level in 2006 was estimated to be 49 million tons of cassava tubers and about 75% of the production is consumed in the form of food. The Presidential Initiative on Cassava Production and Export (PICPE) was officially launched in 2004 and 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. (CBN, 2007; Adeniji, 2007).
- Under PICPE 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 through IITA brought together cassava stakeholders<sup>16</sup> to address the challenge of cassava production and industrial processing which included the design and fabrication of cassava flash dryer.

<sup>14</sup> The third university is the University of Port Harcourt which is also a non-specialized university.

<sup>15</sup> 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).

<sup>16</sup> 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.

- Though principle of flash drying is well known in engineering theory and practice, the principle of flash drying has not been applied in the design of engineering equipment that are used in the processing of indigenous agricultural crops in Nigeria. 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.
- The UNAAB became involved in the project through a senior lecturer that was in IITA for his sabbatical leave when the research project started. His PhD was on instant fufu (a local cassava edible paste) processing technology. 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. He became one of the important researchers on the project. 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.<sup>17</sup>
- UI became involved through a senior lecturer in agricultural engineering who joined the project team in 2004 and played a major role in the engineering design of the flash dryer. The flash dryer project is a combination of original design and reverse engineering. The research team got the efficient and working plant in 2007. The locally fabricated flash driers are generally not designed and thus efficiency is very low.<sup>18</sup>
- After the launch of PICPE, it was 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).
- Attempts to adapt foreign flash dryers have resulted in considerably low performance and frequent equipment breakdowns. This was the experience of Godilogo Farms Ltd 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 factory for equipment maintenance and components fabrication.

<sup>17</sup> For example, the researcher brought to UNAAB the 'Cassava: Adding Value for Africa (CAVA)' project funded by the Gates Foundation through the NRL. 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 research project fund. The university takes only 10% of the fund for administration and bank charges.

<sup>18</sup> Imported flash dryers are expensive, the cheapest costing about ₦3 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.

The main objective of the cassava flash dryer project was to design and fabricate an efficient cassava flash dryer that can withstand the stress of local operating environment. 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-IITA cassava processing research had a feasible design, Godilogo Farm made available its engineering facilities and fund for the fabrication of cassava flash dryer *in situ* at the farm's cassava processing factory.

#### *Progress made*

The progress made in the course of the flash dryer project can be enumerated as follows:

- The launch of PICPE and the commencement of Integrated Cassava project of IITA in 2004 spurred the development of a diesel-operated rotary dryer (300 kg/8h) and a new version of locally fabricated flash dryer with product contact surface made of stainless steel.
- Flash dryer development became necessary in 2004 because of the need to improve the production efficiency, fuel use and robustness of the fufu flour technology. IITA assembled a team of engineers (from IITA, UniPort, UNAAB, UI, FIIRO, and Edo ADP) 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 locally designed and fabricated cassava flash dryer 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 and PICPE provided the initial funding; RTEP supported the design team's visit to collect data from existing flash drying 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.

#### *Outcomes and future prospects*

The main outcome of the UIL was the celebrated local design and fabrication of the first medium sized cassava flash dryer. In the course of the project, there was interactive learning through experimentation by the research team. Other important outcomes may be identified as follows:

- The impact of government policy (PICPE) and government support for the project demonstrated the crucial role of government as a mediator or catalyst for UIL.
- Knowledge flows and user feedbacks play important roles in the success of the UIL.
- Multi-agent commitments and support provided required encouragement and material resources for the project.
- Though the initial success of PICPE's promotion of the instant fufu technology resulted in improved market for the technology, the outlook of the market for the cassava dryer is however unclear. Since most cassava processors are small scale the

cassava flash dryer may attract many users if a smaller and equally efficient version can be produced.

### 5.3. Arms length consultancy

The third type of UIL identified in the three universities is arms length consultancy. Though most consultancies are done by individual scientists rather than at the institutional level, we found one case of institutional level consultancy at the University of Technology. To illustrate this, we have selected the interaction between CERAD and Grand Cereals and Oil Mills Limited (GCOML), Jos, Plateau State in an investigation of the taste-effects of grand soya oil, which is the main product of GCOML.

#### *Initial conditions and objectives*

From the interview and data collected at the University of Technology, the initial conditions that favour the consultancy project can be identified as follows:

- GCOML 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.
- Availability in the university, of research scientists with expertise in the analysis of properties of edibles oils and fats.
- Existence of a research coordinating agency (CERAD) which is able to assemble the expertise required from the relevant university departments.

The objective of the UIL project was to determine whether or not GCOML's 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 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.

#### *Progress made*

The project was carried out laboratory investigations and a consumer survey. The summary of the findings were presented to the company. 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 approved SON<sup>19</sup> standard. Two chemical additives were also recommended to further reduce the index of rancidity of grand soya oil.

#### *Outcomes and future prospects*

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<sup>19</sup> SON is the Standard Organization of Nigeria

Though the UIL was successful, it does not provide much opportunity for interactions that can lead to knowledge intensification in agro-food processing. It was simply a client-service provider type of relationship that enables the service provider to learn only to the extent that the client determines. In the present case, once the client's problem was solved there were no further feedbacks that can advance knowledge.

## 6. OPPORTUNITIES FOR KNOWLEDGE INTENSIFICATION IN AGRO-FOOD PROCESSING

To ascertain the opportunities for knowledge intensification in agro-food processing in Nigeria we will discuss the evidence presented by the findings of this study by applying some elements of the national system of innovation (NSI) and its links with the concept of developmental universities. Universities are known to be centres of knowledge generation and training for community development. In the linear model of innovation, public research especially in the universities generates basic knowledge, which leads to invention, and invention when commercialized becomes innovation. From this simplistic view of the innovation process, the research activities in the universities and public research institutes are isolated from industry. In contrast, the NSI framework demonstrates that innovation takes place as a result of interactions in a network of actors that are involved in the generation and use of knowledge. For industrial innovation, interactions among industrial stakeholders are usually part of the innovation process (Lundvall, 1992; Adeoti, 2002b; Davis and Carden, 1998). In many African economies, the capacity for industrial innovation is weak apparently because the interactive linkages between knowledge producers and users of knowledge are underdeveloped. Besides, several studies that illustrated the NSI framework have proven that economies that are innovation driven (i.e. knowledge economies) are characterized by evident university-industry collaborations especially in strategic sectors of the economy. For Nigeria, the agro-food processing sector is considered strategic for economic diversification and for food security. Nigeria has about 20% of Africa's population, and the oil economy is still Nigeria's main revenue base accounting for more than 70% of foreign exchange earnings while majority of the population depends on the agricultural economy.

In a knowledge economy, university-industry linkages provide opportunities for knowledge intensification required for deepening the innovation process and the advancement of the generation and use of technological knowledge. The ability to undertake innovative research and apply its output is complex and embedded in a context of inter-organizational relationships with active role for the state especially in the newly industrializing economies. From the evidence presented for Nigeria in this study, inter-organizational relationships appear to be weak and the role of the state is still not remarkable in supporting or promoting inter-organizational relationships in the form of university-firm interactions. In one of the three illustrations of UILs (the cassava flash dryer project), the state played an important role through the policy of PICPE. There is however no evidence of the replication of this or ability to sustain the PICPE initiative.

In advanced industrial economies, the interactions between firms and universities are regarded as products of a developmental orientation of research activities as research is aimed at addressing community problems and in many instances research grants are won in competitive bids. For developing countries, the scope and dimension of community oriented research may not be as elaborate as in developed countries. However, there is a growing concern that universities in the South should be alert to the development challenges in their communities and begin a drive to making research and training activities relevant to the immediate societal needs. A developmental university in this context would be actively involved in a network of agents that create new products and services or new models of achieving economic objectives. In essence, a developmental university would not only generate new knowledge that improves the stock of knowledge, but also produce change agents that carry knowledge into society and motivate society to employ and build on knowledge from the ivory towers. While the firm is the centre of the innovative activities in the NSI (Kim, 1997), the developmental university interacts with all other elements of the NSI to create critical skills and impetus for the entrepreneurial functions required to make innovation the engine of growth. The three case study universities in this study are evident knowledge producers in agro-food processing. However, knowledge generation is demonstrated to be often not targeted at community problem solving. Rather, research is done mostly to generate knowledge that are publishable in academic journals mainly to earn promotion. The findings of firm survey also corroborated this, by generally low rating of universities as source of knowledge for innovation. In essence, none of the three universities demonstrated evident characteristics of a developmental university. Moreover, as shown by the constraints on UILs, support from government is weak. Consequently, in spite of their claim of wide experience in addressing local problems through research, it remains uncertain that any of the three universities has capacity to play a sustained developmental role that can result in knowledge intensification in agro-food processing.

It is also important to note that network relationships are dynamic and changing. Accordingly, the conditions for establishing university-firm interactions tend to differ at national levels. For example, in the United States, university, industry, and government are becoming less isolated from each other. In many Latin American countries industries and universities, formerly under strict governmental control, are gaining relative autonomy from the state. In Europe the unification process paradoxically leads to enhancement of the regional and transnational levels of governance simultaneously, with different effects on network relationships in the various member states (Gibbons et al, 1994; Mytelka, 1998; Arocena and Sutz, 2004). It is in this regard that Gibbons *et al* (1994) perhaps observed that a redefinition of the public/private divide has come into focus within the interactions in a knowledge-based economy. This is because academic knowledge is a public good, whereas entrepreneurship requires conditions for private appropriation. In contrast to neo-liberal expectations, the direction is thus not toward laissez-faire. There is an important but not dominant role for government and an enhanced role for the university within the spheres of the network relationship needed to sustain innovation activities. (Keydesdorff and Etzkowitz, 2001). In Nigeria, the evidence presented in this study does not fit into any of these changing modes or characterization of university-firm interaction. In fact, the framework for promoting university-firm

interaction in Nigeria is yet to be established. What currently exists as UILs are rather unplanned occurrences that have not emanated from an official policy or development strategy. This brings to the fore the question of how to promote opportunities for UILs. The results of the firm survey showed that firms seek other sources of knowledge for innovation apart from universities; while the case study of universities demonstrate that UILs that result in knowledge intensification in agro-food processing are not deliberately promoted. The three examples of UILs however underscore the fact that there are potentials for UILs among Nigerian firms and universities, and policy framework that encourages UILs would be beneficial.

## 7. CONCLUSIONS AND POLICY IMPLICATIONS

### 7.1. Conclusions

This study examined the policy mechanisms that determined the features of the National System of Innovation (NSI) in Nigeria in order to set the technological and economic development context for the analysis of university-firm interactions from the perspectives of firms and selected Nigerian universities. An industry survey was carried out; and 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. The study reviewed the extent to which Nigeria's previous economic and social development experiences have constrained or enabled the technological development trajectory. While Nigeria has made diverse and widespread attempts to develop science and technology (S&T), the findings showed that until 2007 development planning process in Nigeria failed to appreciate the central role of science, technology and innovation (STI) in economic and social development. S&T development focused on the supply of scientific knowledge without due consideration for the relevance of knowledge generated to the expected user. The existing apparatus for achieving the objective of scientific development and technological innovation is highly disjointed in establishment, management and operation. It is however demonstrated that policy concerns are beginning to address the challenge of relatively weak national system of innovation characterized by poor linkages between universities, R&D institutions and manufacturing firms.

The firm perspectives from the survey of Nigerian manufacturing firms were investigated with the aim of ascertaining the nature and scope of firms' interaction (or lack of interaction) with universities, and the conditions that constrain the interaction. The results showed that conditions in the firm that constrain university-firm interaction can be broadly classified into two: firm's limited R&D capability, and firm's low perception of the quality of knowledge from the universities. Evidence of limited firm level R&D capability among the research sample firms include existence of innovation mainly in products that are only new to Nigeria and apparently low investment in R&D. Universities took the least position in the perception of firms as sources of information

and knowledge that had resulted in new projects or completion of existing innovative projects. Firms generally perceive the quality of R&D in universities to be low, and hence depend largely on their limited in-house R&D and other sources of technological information.

The evidence of university-firm interactions from the perspective of university practice presented by the three universities confirm that UIL in Nigeria is 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, and
- attitude related.

Two key infrastructure related constraints identified by the interviewees in the three universities include poor research facilities and equipment, and poor electric power supply. Other important infrastructure constraints mentioned are inadequate laboratory or research space, poor access roads to research farms and industrial estates, lack of communication equipments in laboratories and research farms, lack of food halls to display research findings and scale-up facilities or lack of demonstrative pilot plants to help expose research findings.

The findings also revealed that there is no policy that addresses the challenge of university-firm interaction in Nigeria. The respondents in the university case studies profusely narrated the frustration associated with lack of policy on university-industry linkages. In this respect, the constraints associated with university-firms interactions as identified by the respondents include lack of incentives and poor government support for industry R&D, lack of policy to protect intellectual property of scientists, and poor funding of research.

From the results of the interviews, attitudinal issues that constrain university-firm interaction include lack of political will to address R&D challenges, entrepreneurship culture that lack support for R&D, research done mainly for academic publication, and divergent views emanating from the mindsets of scientists and industrialists.

From the analysis of the constraints on university-firm interaction one case of informal UIL between a university lecturer and two firms was highlighted. Three other UILs identified at the institutional level illustrated how UILs in agro-food processing has worked in Nigeria. The three UILs were characterized as principal agent demand-driven, multi-stakeholder problem based, and arms length consultancy. From the evidence presented by the UILs, inter-organizational relationships appear to be weak and the role of the state is still not remarkable in supporting or promoting inter-organizational relationships in the form of university-firm interactions. In one of the three illustrations of UILs (the cassava flash dryer project), the state played an important role through the policy of PICPE. There is however no evidence of the replication of this or ability to sustain the PICPE initiative.



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The illustrations of UILs also showed that the framework for promoting university-firm interaction in Nigeria is yet to be established. What currently exists as UILs are rather unplanned occurrences that have not emanated from an official policy or development strategy. The case study of universities thus demonstrates that UILs that result in knowledge intensification in agro-food processing have not been deliberately promoted.

## 7.2. Policy Implications

The findings of the study show that university-firm interaction in Nigeria is highly constrained both from the perspective of firms and the perspective of universities. The role of government as a mediator is yet to be articulated and existing policy framework for education, science, technology and industrial development remained impotent in fostering university-firm interactions. This, notwithstanding, it is evident from the findings that both industry and the university system recognize the inherent weakness of the university-industry linkage and the need to address it. Flowing from the key findings of the study we make the following suggestions for policy aimed at promoting university-firm interactions that may engender knowledge intensification in agro-food processing.

- i) The results demonstrated that the weak firm-level R&D capability and low quality of knowledge generation by universities are important constraints on UILs. This raises the question of whether or not policy intervention should focus on promoting UILs or simply independently seeking to build firm-level R&D capability and improving quality of knowledge generation at the universities. We suggest that all these should be carried out simultaneously by means of a comprehensive policy framework that supports UILs. The framework should include incentives to strengthen firm R&D and public investments in university R&D. Moreover, building local technological capability would require raising the quality of R&D in universities and active promotion of collaborative R&D projects between firms and universities. Specifically, there should be a national policy on university-industry collaboration. This will specify roles for stakeholders and provide incentive for UILs. The policy should aim at improving government support for research, harmonize results of publicly funded research, and ensure that fund for research is domiciled in a reputable agency mediating between universities and industry.

- ii) The results of the study suggest that the nature of research and training presently offered by the Nigerian university system is limited in its developmental focus. We found no evidence that any of the three universities stimulate risk taking or encourage venture into productive activities. For example, there is no major agricultural farm owned by any of the three universities. It appears that agriculture is currently not looked at as business from the mindset of the educational system. The policy implication of this is that agriculture-related education should be made more attractive and practical oriented. Universities should have business plans to make agriculture work within its training curriculum. Universities should make deliberate effort to 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 linkage could turn into a reality that is of immense benefit to society.
- iii) Government should be the catalyst for university-firm interactions through adequate support for research and use of Nigerian university experts rather than foreign consultants on agro-food related projects.
- iv) The statutes and acts that established universities should be revised to incorporate entrepreneurship tenets into the university teaching and research. This will foster the promotion of the basic philosophy of entrepreneurship as an important aspect of training and research. The outcome of this will further the chances of the occurrence of UILs. Two of the case study universities provide some indication of already moving in this direction. It could be a pathway to generate firm spin-offs from research outputs, and to train students to be self-employed. For example, if students get the right training and entrepreneurship orientation, they will discover that an outcome of biotechnology research can easily give them a one-room agro-food industry which may generate products worth millions of Naira.
- v) To tackle the perennial challenge of government's poor funding of R&D as a major hindrance to UILs, government should re-think its priorities. Funding scientific enquiry especially those that address societal needs should be an important aspect of public expenditure.
- vi) The university system and researchers need a changed attitude to scientific research. Research should connect with society and industry, and not be purely for the sake of academic promotion. A review of the scientific appraisal system in the universities would be necessary to ensure that innovative research is encouraged and rewarded above traditional contribution to knowledge. Like one of the professors interviewed observed, the guiding principle in assessment of scientists should shift from the notion of "publish or perish" to a new culture of "patent, publish and flourish".
- vii) The attitudinal constraints to UILs may also be addressed by education and advocacy programmes that are aimed at providing a re-orientation for the mindset of academics and industrialists. Research should not be mainly to earn promotion while industry should recognize the existence of local research skills and competence. The university curricula review should also progress in consonance with the development dynamics in society and industry. Universities should be conscious of the fact that when their research and teaching are upgraded to world-class standards, they would be approached by industries that are dynamic due to competition in the economic environment.

- viii) An example of infrastructure constraint resulted in informal UIL as narrated in Box 1. Such informal UILs could be further explored by research scientists to forge a link that could be upgraded to institutional level collaboration between the university and relevant firms. As the university and firms improve attitudes and government support for UILs also improves, informal collaborations can become important catalysts of major UILs. Where informal UILs are forged the university should therefore provide resources to advance it.
- ix) There is the need for the establishment of a unit for mediating between university and industry in every university, and an agency that oversee university-industry linkage at the national level. The national institution would act as midwife for promoting innovative demand-driven research and provide incentives for research that addresses societal needs.

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