
The Impact of Scientific Research on Industrialization and Development: The FIIRO Case

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Abstract

The mastery of science and technology as a *sine qua non* for meaningful development is universally acknowledged. Nigeria's recognition of this fact is what informed the establishment over time of 25 scientific research institutes. However, records indicate that in the experience of most developing countries, the effort to utilize scientific R & D for achieving sustainable development has been very disappointing as it has not succeeded in yielding the desired goal. While the degree of success of the various research institutes with regard to living up to their *raison d'être* generally falls short of expectations, the extent of failure is significantly lower and the level of success consequently higher for some than others. FIIRO as an industrial research institute has achieved significant success with regards inventions and innovational output but its impact on industrialization is at best modest. It is the researcher's position that the challenges which have limited FIIRO's performance are largely due to successive governments' actions and inaction. The culpability for the institute's failings can thus be placed squarely at government's doorsteps.

Introduction

Nigeria like other countries apparently recognizes the fact that the mastery of science and technology is a vital necessity for meaningful development.¹ The acknowledgement of the role of scientific Research and Development (R&D) as "...one of the major instruments for transforming a developing country into a developed one,"² would indeed appear to be borne out by the existence of twenty five scientific research institutes in the country.

Records however indicate that in the experience of the preponderant majority of developing countries, the effort to utilize science for achieving economic development has been a very frustrating one as it has failed to yield the desired fruits.³

Nigeria's experience in this regard would not seem to be very different from that of her confreres in Africa, Asia and Latin America for in spite of substantial financial outlays and all the research institutes, the expected outcome remains as elusive as ever.

There is need to point out though, that while the degree of success of the various research institutes in terms of meeting up with the ultimate goal behind their establishment generally falls far short of the nation's expectations, the extent of failure is significantly lower and the level of success consequently higher for some than others. One of such few scientific research organizations adjudged to have been modestly successful with regard to its terms of reference is the Federal Institute of Industrial Research, Oshodi (FIIRO). This assertion finds backing explicitly or implicitly in the works of Osifo⁴, Anya⁵ and Aribisala⁶. Later literatures which support this claim include that of Aju⁷ and Adebayo⁸.

Following from the above, there is a vital need to appraise how much FIIRO has succeeded or failed in carrying out its mandate of stimulating industrial development. The period under examination is from its inception in 1956 to the year 2006 – a total of fifty years

A Brief History of FIIRO

While a detailed history of FIIRO cannot be considered to be within the ambits of this treatise owing to spatial constraints and is in fact the subject of a forthcoming journal paper by this writer, it would still be very germane to outline its history however briefly.

Following a report by the World Bank as an outcome of a comprehensive economic survey carried out on Nigeria, in which it identified a poor orientation with regard to industrial research as well as a recommendation in that direction, the Institute for Applied Technical Research (IATR) was established in 1956. It was vested with the task of undertaking research into the properties, commercial potentials and processing of local raw materials.⁹ The IATR subsequently underwent a change of nomenclature in 1958 to become the Federal Institute of Industrial Research to more clearly reflect its field of activities.

Its terms of reference in 1956 when it was founded were basically to:

- (i) Carry out basic research into the raw materials available in Nigeria for use in industry and the processes which can be used most effectively to convert them;
- (ii) Carry out pilot-scale trials of processes found in the laboratory to be technically feasible
- (iii) Calculate by means of large-scale tests or otherwise, the probable viability of such processes if established on a pilot scale.

FIIRO's history up to 2006 can be divided into three phases or periods. The first period (1956-1970) saw the birth of the institute during the terminal phase of colonial in Nigeria and its tottering steps as an infant organization during the first decade of national self rule. This phase of FIIRO's history was marked by emphasis on the search for local alternatives to imported industrial products and their processing via the utilization of locally available raw materials.¹⁰

The second phase was a period when the institute having found its feet began to entrench itself and record some modest achievements vis-à-vis its terms of reference. This phase of the institute's history was characterized by growing emphasis on the transfer of technology from the institute to industry and allied clients.¹¹

The beginning of the third phase of FIIRO's developmental history (1985-2006) was marked by a worsening in the economic fortunes of the nation to an extent that rendered the importation of important raw materials for industries an increasingly difficult task. The challenges posed by the situation and which was the major challenged faced by the institute during this phase of its history, was the vital need to develop raw materials for industries many of which were folding up owing to the difficulty of securing foreign exchange.

Achievements and Impact

If there is one thing that writers on the subject matter of scientific and especially, industrial research institutions in Nigeria have conceded, it is the fact that majority of these organizations have recorded considerable accomplishments by way of technological breakthroughs and inventions to their credits. FIIRO in particular is widely acknowledged as being the most successful of the four national industrial research institutes with regard to innovational output.

However, since success in terms of breakthroughs does not automatically translate to success with respect to positive impact on industry, the two (achievements and impact) will be separately assessed.

Achievements, breakthroughs and successes of FIIRO

In presenting the achievements of FIIRO, different approaches for classifying them under separate categories are available to a researcher. One of these is categorization based on the respective division of FIIRO from which the specific achievements emanate. This is the approach adopted by FIIRO in some of its publications. Another option is to categorize the achievements based on whether the breakthrough achieved is a product invention or a process innovation. This approach is the one utilized by Adeboye. A third and different approach is to consider the achievement based on the apparent motives or objectives behind the research leading to the breakthrough or innovation. This is the approach used by Aju and this classification system – with slight but important modification is also the one adopted in this study

The said approach involves classification of FIIRO's achievements into three categories, viz: innovations aimed at upgrading indigenous production systems, innovations aimed at import substitution and technical and consultancy services.

Innovations aimed at upgrading indigenous production systems

Innovations categorized under this heading are those motivated by the desire to either mechanize indigenous food production or processing technologies for increased productivity or to improve the quality of traditional foods, beverages, flavour enhancers/seasoners and allied products. In either case, the shelf life of the resulting product is increased and perishability reduced.¹²

One of the most important innovations under the former sub-category (i.e. mechanization) was the development of a manufacturing plant for the production of Gari. This was one of the earliest of FIIRO's research endeavours; the first trials from the pilot plant having taken place in 1960. The full plant consists of various equipment for peeling, grating, de-watering, de-pulping, frying and screening, all of which are electrically operated and are completely mechanized. The same plant can also, with some adaptation, be used to produce cassava flour (Lafun in Yoruba) as well as Fufu.¹³

Another innovation involving the mechanization of indigenous technology which is considered significant is the development of a potable still for the distillation of local gin (Ogogoro). The still which can also distill vinegar, was developed in the late 1960's.¹⁴

Other equipment, machines or plants developed which belong to this sub-category include those for fish smoke drying, miniaturized pounded yam production, cassava starch production, palm wine, cloth dyeing, textile weaving, yam flour as well as for the dry milling of local cereals such as maize, millet, sorghum and cowpea which end products could be utilized for industrial and domestic production of other products like cornflakes, brewing adjuncts, custard powder, *Moimoi* and *Akara*. The most recent of achievements in this sub-

class is a groundnut processing plant which shells, roasts and de-hulls groundnut for peanut butter and sundry groundnut based snacks production.¹⁵

Under the second sub-category (i.e. the improvement of foods and flavouring condiments) FIIRO succeeded in developing proteinous Gari through enrichment with soya bean derived additives. It has in the same vein developed *Kunu* and *Zobo* drinks which are fortified with minerals and vitamins.¹⁶

Other successful endeavours of FIIRO within this sub-class include the production of sparkling wine from sour palm wine and molasses, modernized *Burukutu* (traditional beer brewed from sorghum) and “improved” *Iru* or *Dadawa* (a flavouring condiment made from African locust beans or soyabeans)

Innovations aimed at import substitution

Innovations grouped under this category are mainly those motivated by the desire to source and process local alternatives as substitutes for imported raw materials, the ultimate aim being to reduce the nation’s import dependency thereby conserving her foreign exchange earnings.

Some success was achieved in this respect, one of the most important of which was the development of composite flour as an alternative to wheat flour in the production of bread and confectionery products. The stimulation for this effort arose out of the inability of the country’s farmers to produce more than 5% of the country’s wheat needs. FIIRO’s composite flour consisted mainly of wheat flour mixed with varying proportions of soyabeans flour, sorghum flour and cassava starch. Sequel to government’s ban on wheat importation in 1986, FIIRO also succeeded in developing a non-wheat composite flour which did not incorporate wheat in its composition and can be used for the same purpose as wheat flour.¹⁸

Another significant achievement in this category was the re-discovery of the suitability of the *Gmelina arborea* plant as a short fibre pulp for the purpose of paper making.¹⁹

Similarly, FIIRO was able, in collaboration with PRODA and backed by the financial support of the Science and Technology Ministry, to develop sorghum and maize malts as substitutes to malted barley as raw materials for beer brewing.²⁰

Apart from the foregoing, other raw material innovations of FIIRO in this category are the production of gums, glues, and adhesives from starch, ginger powder, concentrate and oleoresine (for manufacturing ginger ale and ginger beer), refined gypsum, refined kaolin for paints and pharmaceuticals, cocoa fat and palm kernel oil (for making body cream), baker’s yeast, citric acid and glutamate (for manufacturing seasoners).²¹

Others include the production of benniseed oil and resins, foundry crucibles, refractory bricks, floor tiles, electrical porcelain, cold water starch, gluco-amylase enzyme (an industrial enzyme), glucose syrup, microbial culture media, detoxified cassava tuber, starch and waste (for the manufacture of animal feed component and pharmaceutical uses) biogas and biofertilizer, vinegar, tomato powder, starch from sweet potatoes, etc.²²

FIIRO however was not contented with merely developing local alternatives to imported raw materials, it went a step further in some cases by processing local raw materials into finished goods and consumables as substitutes for imported ones. One of the most significant of breakthroughs in this regard was the development of an indigenous alternative to imported weaning food for infants. This product, dubbed soy ogi was derived from the combination of local cereal grains (sorghum, maize or millet), and soya beans which is

reputed for its ability to supply high quality proteins. Others in this class include the production of salad cream, peanut butter, tomato ketchup, wine (from over ripe pawpaw, orange, mango guava, banana and other fruits), vinegar (from palm wine or molasses), fruit juices, adhesives (from animal bones) laundry and toilet soap, non-thermal bricks, chalk from china clay, fibre board, putty (from benniseed), beer (from malted sorghum), etc ²³

Apart from consumables and household utilities FIIRO also succeeded in developing and fabricating simple equipment, machines and manufacturing plants for the production of imported raw materials and finished goods. Since many of these (equipment, machines and plants) are themselves ordinarily imported, their successful fabrication by the institute was itself a major achievement in line with FIIRO's objective of reducing the nation's dependency on foreign goods. Breakthroughs in this connection include the fabrication of a soap reactor, flavour and essence extracting plant, alcohol and vinegar still, automatic weighing and dispensing machine, biogas converter plant, water distillation plant, bottle corking machine, corn decortication and degermer, roller mill, malting plant, tilting furnace (for metal casing), among others. ²⁴

Technical and consultancy services

Industrial research institutes especially in developing countries cannot afford to restrict their roles only to the conducting of research if they are to be very relevant to the developmental aspirations of their countries. They need in addition to render various types of scientific, engineering, technical, techno-economic and socio-economic services to industry and would be entrepreneurs.

This is necessary mainly because of the often limited experience and knowledge of industrialists or entrepreneurs (especially those utilizing technology of foreign origin) in the face of day to day production problems, as well as the need to explore potentials for future expansion among other reasons. In the above respect, the nature of FIIRO's achievement could be gauged from the different kinds of services which it rendered to individuals, private and public sector organizations and which could be grouped under the following categories: contract research, engineering services, analytical services, textile testing, consultancy services, industrial information and extension services as well as training services. ²⁶

It is important to stress the fact that the rendering of these different kinds of service FIIRO is no less an important achievement than the development of innovations and invention. These services could, on the contrary, be even more significant in terms of their impact, especially at the micro and grass root levels, than the institute's technological breakthroughs whose diffusion to the industries (which is what counts most) was below expectations as will be shown in the next section.

The impact of FIIRO on industry, economy and society

As shown in the preceding section, FIIRO undoubtedly had a substantial number of achievements of significant import and potentials to its credit in terms of inventions, breakthroughs and services. But as stated at the beginning earlier, it is not the number of innovations and technological triumphs recorded that counts most. What is even more important is the extent to which these have diffused to industrial as well as the degree of impact their utilization has had over the years on industrialization, national economy and the ordinary man in the street. A critical assessment of this constitutes the focus of this section.

Extent of diffusion

The researcher's effort to obtain comprehensive data on the full extent of diffusion of FIIRO's, innovation up to 2006 was not completely successful. Nevertheless a lot of

information (diffusion wise) up to 1995 was obtained from Titus Adeboye's study of "Diffusion of Inventions in Nigeria". This was substantially complemented by data gleaned from other sources, most notably, FIIRO itself.

In Adeboye's study he indicated that 25 inventions had come from FIIRO out of which seven (mechanized Gari making, potable alcohol, bottled palm wine, Nico cream, smoke curing of fish, sparkling wine and soap making) have diffused to outside manufacturers. Three others (soy ogi, gari flour and fufu) he stated were then being produced by FIIRO itself in pilot plants and had been commercialized.²⁷

The above picture painted of the extent of diffusion of inventions emanating from FIIRO albeit accurate with regards to the seven inventions given as having diffused to manufacturers is however incomplete in some respects. Firstly is the fact that the total number of FIIRO's inventions (major and minor) which it gives as 25 is very inaccurate (a figure of fifty being closer to the mark even as at 1995) and that some out of those he failed to include on his list may have diffused to entrepreneurs as at 1995.

An example is FIIRO's discovery of the Gmelina plant's suitability for paper making, its extensive cultivation in plantations and the subsequent establishment of three different paper mills using Gmelina as raw materials.²⁸

Another limitation of Adeboye's figures is that since his study the number of entrepreneurs who had adopted the innovations on his list had probably increased while some other innovations of FIIRO's which had not been adopted as at the time of his study must have diffused beyond the institute's confines. One notable example for which evidence is available is the infant weaning food, soy ogi. As at 2006 at least one beverage company, Nestle Foods Plc had obtained FIIRO's license to produce soy ogi and was marketing it under the brand name Nutrend.²⁹ Even as at 1994, three other firms had already adapted the soy ogi innovation,³⁰ thus it had diffused directly and indirectly to at least four companies. Other FIIRO innovations which may have diffused as at 2006 include improved textile weaving, dye jig for pit dryers, vegetable oil extraction from benniseed, and groundnut processing plant.³¹

As for four other innovations namely: mechanized gari flour production, mechanized fufu production, smoke curing of fish using FIIRO's kiln and sparkling wine production, each of these had been adopted officially by only one entrepreneur (see table 1). Nico cream (cocoa butter) production on the other hand had been adopted by two firms one of which, (the Continental Pharmaceuticals Limited CPL) was producing it under the brand names *Afro Cocoa butter cream* and *Afro Cocoa butter lotion*.

Table 1: **FIIRO Innovations and Adopters**

Innovations	No of adopters
Mechanized gari flour production	1
Smoke curing fish	1
Nico cream	2
Potable alcohol	4
Paper production using Gmelina	3
Soy ogi	2
Gari processing plant	6
Bottled palm wine production	60
Soap manufacture	40
Mechanized fufu production	1

Sparkling wine production	1
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Adapted with modification and updating from Adeboye, "Diffusion of Innovation in Nigeria"

Although potable alcohol production using FIIRO still had directly been adopted by at least four users, countless number of "Ogogoro" (local gin) producers had made adaptations based on the FIIRO technology. The situation is similar for the FIIRO Gari processing plant which had been adopted by at least six users within Nigeria (and had also been adopted in five West African Nations). Very popular in this regard also is the grater, a component of the Gari manufacturing plant.³²

Bottled palm wine and soap making on the other hand, were the most widely diffused innovations of FIIRO through direct adoption. About 60, out of over 500 individuals who underwent training on the bottled palm wine, had officially adopted it. Soap making on the other hand had been taught to more than 600 private individuals by FIIRO but with only 40 officially confirmed adopters. A study of the adoption rate of small scale technologies among FIIRO trained entrepreneurs in South Western Nigeria (which is Nigeria's industrial nerve centre) reveals a figure of 41% with the highest for soap and body cream. This is said to be very high going by international standards.³⁸

Degree of impact

Without doubt FIIRO's existence would, like that of other scientific research institutes, be considered by the average Nigerian as having accrued little or no benefits for the nation and funds expended on it as just money down the drain. The truth of the matter however is that gauging the performance of a scientific research organization is no easy task. In any case FIIRO can, unlike the case with some other research institutes, justifiably quantify its achievements not only in terms of various innovations and breakthroughs but also a modest degree of tangible impact on industry, economy and society.

One of the most significant contributions of FIIRO to the national economy was in reducing the country's import dependency with respect to certain raw materials and goods and in the process conserving foreign exchange. The use of Gmelina for paper production as an example, undoubtedly reduced the nation's dependency in this respect and saved her substantial foreign exchange. The same goes for soap production in which area FIIRO's activities contributed to boosting domestic productive capability. FIIRO transfer of technology on soap production commenced in 1986 and it comes as no surprise that between that year and 1993, the domestic manufacture of soaps and detergent is said to have increased from 17,702 metric tones to 303,465 metric tones with 10 port of soap is claimed to have dropped from 300 tones in 1989 to 2 tones in 1990.³⁴

It is estimated that FIIRO "import substitution projects directed towards the brewing industry saved the country about £570 million between 1987 and 1988"³⁵ As a result of this breakthrough, multinational like Nestle and Cadbury as well as Northern Brewery PLC proceeded to establish sorghum malting plant following FIIRO's cue. Similarly, FIIRO's development of non-wheat composite flour was what emboldened the government to place a ban on wheat production in 1985 and, as a follow up, attempt to boost local wheat production. Thus FIIRO's composite flour breakthrough not only led to a reduction of national dependency on wheat imports following the ban, but saved the nation £50 million between 1986 and 1987 alone.³⁶ Studies on the economic impact of FIIRO's various technologies showed that these items had made possible a total import saving of N4.8 billion per annum.³⁷

Allied to the conserving of foreign exchange highlighted above is the fact that in some cases, the nation's foreign exchange earnings were actually boosted. For example soap export increased steadily from 15 tonnes in 1986 to more than 198 tonnes in 1992.³⁸ FIIRO itself earned its largest foreign exchange through packaging and installation of small scale Gari processing plants in five African countries under contract from UNIDO.³⁹ The earlier mentioned studies of the impact of FIIRO technologies which reveal a net saving of N4.5 million yearly for the nation also shows that these items have an export value of £255,000 annually.⁴⁰

Of even greater interest to this researcher is the fact that the exports which emanated from FIIRO have not been restricted to consumer items, equipment and raw materials alone, but apparently includes even technological know - how in the form of research information on its innovations and the breakthroughs which " ... foreign companies used to promote the adaptation of goods to the Nigeria environment since results were often published in journals and accessible research reports"⁴¹ This undoubtedly is what Aribisala refers to as "Technological reversal" in her work.⁴²

Another important contribution of FIIRO to national industrial development during the period under consideration was its direct and indirect boosting of industrial expansion as well as improvement in quality and standard of industrial products through various means. These included assisting factories to set up their own quality control laboratories for food and drinks, collaborating with the Standards Organization of Nigeria (SON) and the National Agency for Food and Drug Administration and Control (NAFDAC) in testing products for those desiring certification and generally assisting industries in various ways via its Technical Assistance Scheme (TAS).⁴³ An indication of potential benefits of the TAS can be gleaned from the calibre of some of the companies which have benefited from it which includes such multinationals as Lever Brothers PLC, Cadbury PLC, Glaxo-Wellcome PLC, and Texaco as well as indigenous "heavy weights" like the National Steel Commission, North Breweries Limited and the Nigeria Grains Production Company (See table 2)

Members of the general public also benefited either directly or indirectly not only through the areas enumerated above, but also by other means as well. One of these was the fact that income was boosted for Nigerian farmers⁴⁴ especially the cultivators of wheat, Sorghum, Soyabean, and to a lesser degree, maize as a result of FIIRO's activities which resulted in these cereals becoming highly sought after by industries. Another means by which the ordinary citizens benefited from FIIRO's activities is that they (FIIRO's activities) reportedly resulted in the direct and indirect creation of 185,000 jobs (1996 estimate) "mainly for production workers, equipment fabrication and sales personnel, farm labourers, etc."⁴⁵ Furthermore FIIRO's Technology, Marketing and Extension Services sections had by 1996 trained 1,500 entrepreneurs and would be entrepreneurs in various production technologies.⁴⁶

However, inspite of the foregoing, there is need to examine the reverse side of the scenario in order to maintain critical balance so that FIIRO's achievement and impact do not end up looking more impressive than they really are.

One of FIIRO's major failing was the fact that while the number of breakthroughs it achieved appear to be fairly impressive, the rate of diffusion/adoption of these innovations and most especially FIIRO's overall impact on industrialization falls short of expectations.

Table 2: **Beneficiaries FROM FIIRO'S Technical Assistance Services (TAS)**

NO.	COMPANY	TYPE OF TAS
1.	National Steel Commission, Jos	Establishment of electroplating works
2.	Glaxo Wellcome Plc, Agbara	Dry milling of cereals and legume flour for baby food production
3.	Nigerian Grains Production Company, Kaduna	Dry milling of cereals into flour
4.	Jolly Brothers Limited Kaduna	Dry milling of cereals into flour
5.	Tate and Lyle Limited, Sango Ota	Maize milling for cornflakes production
6.	Lisabi Mills Limited, Ikorodu	Starch production and Dry milling of cereals
7.	Eddy and Brothers Enter. Shomolu	Palm wine bottling and preservation
8.	Moas Trading Company, Lagos	Laundry and Toilet Soap production
9.	Nikky Enterprises, Ipaja	Body and hair pomade production
10.	Thona Enterprises Limited, Lagos	Laundry and toilet soap production
11.	Ladun enterprises Limited, Ipaja	Laundry and toilet soap production
12.	Cadbury Plc, Agidingbi	Sorghum malt/syrup production
13.	Buckingham Limited, Apapa	Soy ogi production
14.	Continental Pharmaceutical Plc	Cocoa butter based skin cream
15.	International Breweries Limited	Sorghum Malt production
16.	North Breweries Limited, Jos	Sorghum bear and sorghum malt
17.	Texagric Limited (Texaco Nigeria Ltd)	Mechanized gari and starch production
18.	Lipton/Lever Brothers Plc, Apapa	Preparation of herbal infusion for production of tea

Adapted from untitled FIIRO material

Secondly is the fact that some of its innovations do not seem to have much relevance to the actual need of society and more importantly, the industries which it was established to assist. This would appear to be because its research scientists are largely left alone to determine research projects which are quite wrong, for scientists are never the best qualified persons to decide what the needs and priorities of a nation are.⁴⁷ This was one of the major factors which militated against the diffusion of its breakthrough, for as a researcher has indicated, diffusion is swift when innovation is "... a direct response to an expressed need, especially a need expressed by the ultimate user of the product or process"⁴⁸

Another significant failing of FIIRO's is that those of its innovations, which appear to address the important problem of dependence such as Sorghum malt, composite flour, soy ogi and ginger powder, oleoresin and concentrates, have either diffused only to a very modest extent as in the case of barley malt and soy ogi or almost not all (composite flour and ginger derivatives).

Conclusion

In concluding this treatise, it is vital having appraised the achievements (inventions, innovations, etc) and impact (on industrialization and society) of FIIRO to also identify the problems and challenges behind the institute's performance being at the level it is. Such an exercise has perforce to be brief owing to space limitation.

Majority of the problems which have acted as constraints to greater achievements by FIIRO basically have to do with finance in one way or the other. They include inadequacy of qualified and experienced scientific staff, inadequacy of laboratory and workshop equipment and high research staff turnover (probably not unconnected with dissatisfaction with the level of remuneration)⁴⁹ among others.

The challenges confronting the institute in the area of impact are among those with which research institutes in developing countries are generally faced and are mainly two. The first of this is what Onyike calls "breakdown of inter-institutional linkages"⁵⁰ and has to do with the failure of these institutes to establish firm links with the manufacturing sector so as to know their actual needs. Moreover even in the few instances when the results of the research endeavors of FIIRO and similar organizations do reflect the real needs of industry, there is often a lack of effective demand for such research products. Rather, local firms prefer to orient their demands for technology towards foreign sources. This is basically because they place greater faith in the experience and know-how of foreign technologies which is after all ready "tried and tested". This is what is referred to as Cooper's theories of "marginalization of Science" and "technological dependence"⁵¹ and constitutes the second problem alluded to above.

In the final analysis, it is clear that majority, if infact not all, of the problems and challenges enumerated above have directly or indirectly to do with the actions and inactions of succeeding Nigerian governments and subsequently the blame for the status quo can be placed squarely at the government's doorsteps.

All in all, it can be stated that FIIRO certainly deserves some kudos for its modest attainments. Moreover it is necessary to again reiterate the fact that the assessment of the overall performance of FIIRO, both at micro and macro levels, is surely bound to be a difficult task for "while the performance in health and manufacturing can easily be measured and indeed appears obvious, indicators for measuring performance of industrial research are not as obvious."⁵²

NOTES

¹ Yinka Omoregbe, "The Legal Framework and Policy for Technology Development in Nigeria: in *African Journal of International and Comparative Law*. Vo. 3, pt. 1, 1991, p. 156

² S. A. Odunfa, "Welcome Address" in *The Development of Technologies in Nigeria: Papers presented in commemoration of FIIRO 40th Anniversary (Lagos, 1994) p. 3*

³ Aju, p. 87

⁴ O.J. Onyike, "Technological Research Institutes as Agents of Industrial Growth" in D.E. Osifo (ed), "*The Role of Technology in the Development of Nigeria* (Ibadan: Heinemann, 1982)

⁵ A.O. Anya, *Science and the Crisis in African Development*, (Lagos: Ida – Ivory Press 1993)

⁶ O.A. Aribisala, *Raw Materials Revolution and its Impact on Industrialization in Nigeria* (Lagos: Mednet. 1993)

- ⁷ Akin Aju, *Industrialization and Technological Innovation in an African Economy* (Lagos J: RECTEM, 1995)
- ⁸ Titus Adeboye “Diffusion of innovation in Nigeria” in O.M. Ogbu, B.O. Oyeyinka and H.M. Mlawa, *Technology Policy and Practice in Africa* (Canada: IDRC, 1995)
- ⁹ Aju, pp 201-202,
- ¹⁰ Aju, p. 221
- ¹¹ Aju, p. 222
- ¹² FIIRO, *Special Research Report*, n.d.
- ¹³ O. Olatunji, “Welcome Address to Professor Turner T. Isoun Honourable Minister of Science and Technology on the Occasion of his visit to FIIRO” 13th July, 2001, p. 5
- ¹⁴ S.A. Odunfa, “Welcome Address” in *Development of Technological Capacities in Nigeria: Papers Presented in Commemoration of FIIRO's 40th Anniversary* (Lagos: FIIRO, 1996) p. 6
- ¹⁵ FIIRO *Special Research Report*
- ¹⁶ Odunfa, p. 2
- ¹⁷ Olatunji, p. 2
- ¹⁸ Olatunji, p. 4
- ¹⁹ FIIRO's Special Research Report
- ²⁰ FIIRO, Special Research Report
- ²¹ FIIRO, Special Research Report
- ²² FIIRO, Special Research Report
- ²³ Jones, p. 123
- ²⁴ FIIRO, “FIIRO: Industrialization Through Research and Development” n.d
- ²⁵ Adeboye, p. 123
- ²⁶ Olatunji, p. 4
- ²⁷ Olatunji, p. 4
- ²⁸ Aju, p. 230
- ²⁹ Olatunji p. 4
- ³⁰ Aju, p.p. 223-24
- ³¹ Odunfa, p.p. 12-13
- ³² Odunfa, p. 12
- ³³ Odunfa, p. 11
- ³⁴ Odunfa, p.
- ³⁵ Odunfa, p. 13
- ³⁶ Odunfa, p. 12
- ³⁷ Olatunji, p. 6
- ³⁸ Odunfa, p. 13
- ³⁹ Odunfa, p. 3
- ⁴⁰ Aribisala, p. 218
- ⁴¹ Olatunji, p. 5
- ⁴² Odunfa, p. 5
- ⁴³ Odunfa, p. 13
- ⁴⁴ Odunfa, p. 10
- ⁴⁵ Aju, p.p. 210-213
- ⁴⁶ Adeboye, p. 125
- ⁴⁷ Aju, p. 217
- ⁴⁸ Olatunji, p. 7

⁴⁹ O. J. Onyike, “Technological Research Institutes as Agents of Industrial Growth” in D.E. Osifo (ed) *The Role of Technology in the Development of Nigeria* (Ibadan: Heineman, 1982) p. 303

⁵⁰ O. Olatunji “Welcome Address to Professor Turner T. Isoun, Honourable Minister of Science and Technology on the Occasion of his visit to FIIRO” 13th July, 2001, p. 7

⁵¹ Onyike p. 304

⁵² Aju, p. 87