

Positioning Biotechnology for Nigeria's Industrialization

Tonukari, N. J.

Department of Biochemistry, Delta State University, Abraka, Nigeria.

Abstract

Most of the activities concerning biotechnology in Nigeria are still in the laboratory research stage. More pragmatic effort is now needed to translate the results of biotechnological research into commercial products and processes as well as general economic development. Also, concerted effort to create companies for specific products and services using industrial biotechnology is required in Nigeria.

Keywords: Biotechnology, Industrialization, Biocatalysis, Commercialization.

Corresponding authors email: n.tonukari@delsu.edu.ng, tonukari@gmail.com

Introduction

Industrialization involves the organization of human skills and efforts to manufacture valuable products from natural resources and primary products. It also includes the development of technological competences that improve manufacturing processes for quality products. This stimulates economic development as it will raise the level of production and employment, as well as income growth.

Biotechnology is a field of science and technology with an interdisciplinary outlook that deals specifically with the changes encountered by living and non-living matter using active organisms. Products derived from these biological processes are of useful basic knowledge as well as prototypes for the creation of goods and services (Tonukari, 2004, 2011; Acquah et al., 2006; Dubin, 2007; Tonukari et al., 2010). The biotechnology industry is a rigorous knowledge-driven science sector which aims at the overall advance of natural sciences (Aghmiuni et al., 2020). The promise of an industrial revolution lies at the heart of biotechnology. Some companies operate in statutory environment, but biotechnologies can be integrated into their production processes to reduce environmental impact and enhance their outputs (Calzoni et al., 2019).

Biocatalysis and enzymatic pathway development are the key to transformation and innovation in industrial biotechnology (Wohlgemuth, 2009). Biocatalysis is now integrated into several industrial sectors, with capacity to control bioprocesses such as enzymatic activity and reaction kinetics in microorganisms, while keeping waste products and toxins minimal. Biocatalytic processes have been adopted in the pharmaceutical and food sectors as well as in the production of biofuels and biochemicals (Calzoni et al., 2019). In general, renewable energy from biomass and waste can be utilized to produce bulk chemicals and biomaterials.

Pioneering sectors of modern economy adopt advanced technology as a fulcrum for modern development. The biotechnology industry can be described as totally encompassing in approach both in research and development as highlighted by researchers (Cooke, 2004). Development of biotechnology is of immense value to the functioning of emerging economies. In technologically advanced industries, progress is difficult without access to research and development for the creation of knowledge which is the bedrock of innovation and technological advancement in institutions (Mrozowski, 2020). The research of Aghmiuni et al. (2020) revealed that research development policies,

and government strategies have an impact on the development of biotechnology significantly

The local Nigerian biotechnology industry is yet to even take off, thus providing numerous opportunities for all comers. The purpose of this article is to encourage researchers in Nigerian universities and research institutes to take their findings from the laboratory to factories for production, since no established companies are stepping forward to implement their discoveries and inventions. The article also examines the opportunities available for the exploitation of biotechnology for Nigeria's much needed industrialization.

Potential of Biotechnology in Nigeria

Most developing countries including Nigeria have very little modern industrial biotechnology. The continuous reliance on foreign skills and knowledge has led to technological stagnation in Nigeria. Lall (1992) reviewed the nature of technological development in advanced climes and hypothesized on the nature of technology imported and the form that technology imports take which affect technological capabilities and development. Biotechnology can be a major force for Nigeria's industrial development. Several items now currently imported that can be produced using biotechnological processes include industrial enzymes (protease, amylase, lipase), vaccines, vitamins (A and C), amino acids (methionine, lysine, threonine), single cell proteins, organic acids (lactic acid, acetic acid, glutamic acid), probiotics, monoclonal antibodies and biofertilizers.

Nigeria has a large scientific potential to pursue a significant improvement of the biotechnology industry and enterprises with specialty on the creation of pioneering solutions. This potential is based on the thousands of scientists employed in universities and research institutes with expertise in genomics, DNA- and RNA-based technologies, cell and tissue culture and fermentation technologies. However, biotechnological innovation involves finding a profitable application of the knowledge or idea that has been created in the laboratory.

The gap between the competences required in the biotechnology industry and those acquired at universities is drawing more attention (Delebecque and Philp, 2019; Treanor et al., 2021). There is also a large gap for academic research to advance from the technological prototyping at laboratory scale to actual commercialization in industry (Kampers et al., 2022). Current innovation culture requires employees to possess skills and competence which are often beyond the traditional basic knowledge taught at undergraduate and postgraduate levels (Meissner and Shmatko, 2019). There is a need to bridge this gap between regular

university courses and the need for educated professionals in the biotechnology business. A starting point will be a short certificate course in business and engineering for graduates in biotechnology-related courses.

Biotechnology Incubators and Commercialization

The most essential obstacle for the commercialization of research findings in biotechnology includes limited experience in cooperation between universities and research institutes with business and dearth of scientific entrepreneurs. For the growth of biotechnology spin-offs and start-ups for global competition, the overall innovation of the economy and conditions for the commercialization of scientific research are important (Mrozowski, 2020).

Institution and direct government support, such as biotechnology incubators, technology transfer centers or science and technology parks are required to bridge the gap between the laboratory prototype and factory production (Tonukari, 2008). The research institutes naturally ought to take the lead in setting up biotechnology incubators and pilot plants for scientists all over the country to try out their ideas and innovations. National and state governments that are keen on developing the biotechnology enterprise can also support their scientists and academic entrepreneurs by also creating bio-incubators (Aghmiuni et al., 2020). Research institutes' scientists who devote their full time to research should draw lecturers to their institutes, so that they can collaborate and use their pilot plants to manufacture products and services conceived in universities' laboratories.

An important limitation of the development of the biotechnology sector is the low availability of experienced entrepreneurs among members of the scientific and research team who understand what is necessary to establish and develop a successful company in the field of biotechnology (Shimasaki, 2009). The importance of developing entrepreneurial competences in early career researchers in the biotechnology field is increasingly acknowledged (Treanor et al., 2021).

Commercialization can be through consulting services, research contracting, patenting, and creating spin-off companies (Landry et al, 2006). Spin-offs are new companies fashioned by adherents of the academic community to commercialize technology as an element of intellectual property created in their institutions (Shane, 2004). Currently, there is no pressure from universities or government to get scientists to commercialize their research. Moreover, academics are limited by technical factors in their drive to develop industrial products from their research (Kampers et al., 2022). Academic entrepreneurship has now become

extremely important in the contemporary knowledge-driven economy. Academic entrepreneurs are researchers that can create and visualize opportunities and organize the necessary resources leading to the creation of new goods and services (Klimek and Klimek, 2010).

National Policy on Industrial Biotechnology

The know-how of biotechnological knowledge is the creation of fundamental and gradual improvements as well as applications that create wealth for countries (Aghmiuni et al., 2020). A government policy encouraging the establishment of biotechnology companies is urgently needed in Nigeria. In addition, a special competitive zero-or low-interest fund for commercialization of proven products or processes from biotechnology research will strongly motivate Nigerian biotechnologists. Such a fund can be established by the banks plus other financial institutions with the Federal Government providing a significant part of the fund. This is important in developing countries like Nigeria that are latecomers to the biotechnology industry, and where venture capital is yet to be developed (Shin et al., 2019). Researchers can apply for loans from such fund to establish a factory or firm for the translation of laboratory work into goods and services. In this way, several biotechnology startups will appear all over Nigeria every year. This will be of immense benefit to the Nigerian economy.

A national annual biotechnology exhibition week should be established to provide a platform for biotechnology professionals in universities, research institutes and industry to display their products and technologies. This can be initiated by biotechnology companies, research institutes and universities, while government and other stakeholders will buy into it later and support it financially. Such exhibitions should highlight pure inventions or novel ideas as well as locally produced alternatives to imported products, processes, and services.

Perspectives

National prosperity strongly depends on industrialization. Industrial biotechnology has become a challenge that Nigeria must engage in for sustainable development, with the capacity of generating value and employment. There is a potential huge market for biotechnological products and services in Nigeria. The challenge is now in finding ways of moving scientific discoveries currently stuck in the laboratories and publications/book shelves to the real world where they can make tangible differences in the economy. Due to the lack of companies

and businesses involved in biotechnology in the country, Nigerian academics and researchers must take a leading role in establishing bio-based industries and leveraging the knowledge gleaned from research for the manufacturing of innovative products and processes as well as in generating employment and creating values. Realizing the dream of an industrial biotechnology revolution in Nigeria will take a lot of courage and imagination. This will require a new methodology that will spotlight the industry at epicenter supported by universities and research institutes. Nevertheless, the lack of easily accessible capital will also create difficulties for biotechnology professionals to enter the vast world of industry where other skills in management and engineering are required. By enabling the survival of biotechnology startups with competent products and services, their technologies could drive the development of the new manufacturing and consulting companies for the overall growth of the Nigerian bioeconomy.

References

- Acquaah, G., Ude, G., Matand, K., and Tonukari, N. J. (2006). Agricultural biotechnology and developing countries: prospects, challenges, and impact. *Floriculture, Ornamental Plant biotechnol.*, pp.314-327.
- Aghmiuni, S. K., Siyal, S., Wang, Q., and Duan, Y. (2020). Assessment of factors affecting innovation policy in biotechnology. *J. Innov. Knowl.*, 5(3):180–190.
- Calzoni, E., Cesaretti, A., and Emiliani, C. (2019). Creating Products and Services in Industrial Biotechnology. In *Introduction to Biotech Entrepreneurship: From Idea to Business* (pp. 129-139). Springer, Cham.
- Cooke P., (2004). The accelerating evolution of biotech clusters, "European Planning Studies", 12(7):915–920.
- Delebecque, C.J. and Philp, J. (2019), Education and training for industrial biotechnology and engineering biology. *Eng. Biol.*, 3: 6-11. <https://doi.org/10.1049/enb.2018.0001>
- Dubin A. (red.), (2007), Stan i kierunki rozwoju biogospodarki, Ministerstwo Nauki i Szkolnictwa Wyższego, Warszawa.
- Kampers, L. F., Asin-Garcia, E., Schaap, P. J., Wagemakers, A., and dos Santos, V. A. M. (2022). Navigating the Valley of Death: Perceptions of Industry and Academia on Production Platforms and Opportunities in Biotechnology. *EFB Bioeconomy J.*, 2:100033.

Klimek J., and Klimek S., (2010). *Przedsiębiorczość bez tajemnic*, Wydawnictwo Adam Marszałek, Toruń.

Lall, S. (1992). Technological capabilities and industrialization. *World Dev.*, 20(2):165-186.

Landry R., Amara N., and Rherrad I., (2006). Why are some university researchers more likely to create spin-offs than others? Evidence from Canadian universities. *Res. Policy*, 35(10):1599-1615.

Li, Z., Ji, X., Kan, S., Qiao, H., Jiang, M., Lu, D., Wang, J., Huang, H., Jia, H., Ouyuang, P. and Ying, H. (2010). Past, present, and future industrial biotechnology in China. *Biotechnology in China II*, pp. 1-42.

MarketsandMarkets, (2016). *Industrial Enzymes Market by Type & Source - Global Forecast 2022* MarketsandMarkets .

Mrozowski, P. (2020). The determinants of biotechnology development by academic entrepreneurship and spin-off companies in the commercialization process of scientific research results in Poland. *Journal of Management Challenges*, 1(1), Wydawnictwo Politechniki Łódzkiej, Łódź 2020, ISSN 0137-2599.

Shane S., (2004). *Academic Entrepreneurship: University Spinoffs and Wealth Creation*, Edward Elgar Publishing, Cheltenham, UK, Northampton, MA, USA.

Shimasaki C., (2009). *The Business of Bioscience. What Goes into Making a Biotechnology Product*, Springer, London-New York.

Shin, K., Choy, M., Lee, C., and Park, G. (2019). Government R&D subsidy and additionality of biotechnology firms: The case of the South Korean biotechnology industry. *Sustainability*, 11(6):1583.

Tonukari, N. J. (2004). Fostering biotechnology entrepreneurship in developing countries. *Afr. J. Biotechnol.*, 3(6):299-301.

Tonukari, N. J. (2008). Africa needs biotechnology incubators. *Biotechnology*, 7(4):803-807.

Tonukari, N. J. (2011). *Introduction to Molecular Biotechnology*. Delta State University Abiraka Publications.

Tonukari, N. J., Awioroko, O. J., and Ehwerhemuepha, T. (2010). Diverse applications of biotechnology. *Sci. Res. Essays*, 5(9):826-831.

Treanor, L., Noke, H., Marlow, S. and Mosey, S. (2021). Developing entrepreneurial competences in biotechnology early career researchers to support long-term entrepreneurial career outcomes. *Technol. Forecast. Soc. Change*, 164:120031. <https://doi.org/10.1016/j.techfore.2020.120031>.

Wohlgemuth, R. (2009). The locks and keys to industrial biotechnology. *New Biotechnol.*, 25(4):204-213.