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Biotechnology and Entrepreneurship in Developed and Developing Countries

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Abstract

Biotechnology entrepreneurship is now associated with a sustained flow of innovations and tools, offering dramatic improvements in human health and a compelling value proposition for health care and agricultural consumers as a result of entrepreneurial orientation being applied. Biotechnology entrepreneurship in developed and developing nations like that of Japan, China, India and that of Nigeria and even some Asian countries is relatively new and distinct field of entrepreneurial endeavors. Most current empirical researches are conducted in the developed economies and cannot be directly extrapolated to the developing economies. This research used a qualitative research method. The data collection methods were interviews, documents review and observations, which improved the quality of the research through data triangulation. In addition, some factors that influence the process of biotechnology entrepreneurship in developed and developing countries were identified as regulation, funding, infrastructure, skills, entrepreneurial and commercialization capabilities, etc. Biotechnology entrepreneurship in developed countries predominantly uses the "system approach" and the "individual approach" in developing nations. The process of biotechnology entrepreneurship in developed countries differs from the process in developing nations due to the differences in the environmental factors that influence biotechnology entrepreneurship, and management strategies, in these economies.

Keywords: Biotechnology Entrepreneurship; Entrepreneurship; Biotechnology; Management Strategies; Developed and Developing Nations.

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1. Introduction

Entrepreneurship is described as the pursuit of market opportunities to create future innovative goods and services discovered, evaluated and exploited to extract social and economic values from the environment, leading ultimately to new independent business / venture creation [1]. An entrepreneur is often considered as a person who sets up his/her own business or industry, through the application of his/her initiative, drive, skill and spirit of innovation aiming at high goals [16]. Biotechnology is multidisciplinary encompassing microbiology, chemistry, biochemistry, genetics, molecular biology, immunology, cell and tissue culture and physiology, as well as engineering. Proponents around the world project a positive future in which biotechnology overcomes food shortages, improves the environment, heals or eliminates disease and leads to a prosperous and healthy society. Biotechnology is defined as the application of science and technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services [19]. Products and services that are derived from biotechnology has been the driving force behind the establishment of biotechnology companies for entrepreneurial purpose. For the pharmaceutical sector, these products include recombinant vaccines, hormones, vitamins and antibiotics. In plant, biotechnology engineering for insect and disease resistance, as well as storage protein and other nutritional improvements has been the trend.

Furthermore, potential benefits from tissue culture, bio-fertilizers, bio-pesticides, and medicinal plants are tremendous. Plants also have considerable potential for the production of biopharmaceutical products because they can be genetically transformed. Delivery of a biopharmaceutical product by direct ingestion of the modified plant removing the need for purification is very promising. Such biopharmaceutical proteins and edible vaccines can be stored and distributed as seeds, tubers, or fruits, making immunization programs in developing countries cheaper and potentially easier to administer (Shane, 2003). Efficient sewage treatment and degradation of petroleum and management of oil spills by genetically modified microorganisms can be applied to improve the environment. Industrial biotechnology has evolved as a significant manufacturing tool for products like fuel-grade ethanol, organic acids and bulk amino acids. Current development projects within the chemical industry, including lactic acid and biodegradable plastics, indicate that new biotechnological processes and products may soon approach the market place as alternatives to petrochemical products," [5].

Developing countries are already benefiting and should continue to benefit significantly from advances in plant biotechnology. Insect-protected cotton containing a natural insecticide protein from *Bacillus thuringiensis* (*Bi* cotton) is providing millions of farmers with increased yields, reduced insecticide costs and

fewer health risks. Many other useful plant biotechnology products that can benefit poor farmers and consumers are in the research and development pipelines of institutions in developing countries and should soon reach farmers' fields. Biotechnology entrepreneurship research requires the collaboration of human talent, capital and institutions to achieve economic and social development, job creation, poverty alleviation, skills development and technology transfer. These benefits have captured the interest of the developed and developing economies in programs and activities aimed at promoting biotechnology entrepreneurship, in order to capitalize on what has been termed the "Bio-century" [4].

Therefore, biotechnology entrepreneurship involves the psychological/sociological attributes necessary for the individual to function effectively as an entrepreneur in a higher level of cognitive functioning, motivation, leadership qualities, and propensity to take risk, action-orientation, and self-efficacy, preference for autonomy, self-direction, and differential access. These kinds of entrepreneurs tend to take their time, to plan, organized and analyze their enterprenual system, which is required to develop a conceptual idea into a viable product/service [15].

Biotechnology entrepreneurs recognize the value of technology and creatively and innovatively introduced new ways of using it in transforming their industries for better performance [21]. They also make much use of computers, the internet and other modern advancements in developing their business venture and operations. Their skill sets are therefore predominantly technical rather than business oriented [14].

1.1. Biotechnology and Entrepreneurship

Biotechnology is the framework of biology and engineering. It is a combination of pure science such as medical science, biochemistry, molecular biology, cell biology and industrial production in the areas of medical, food, forest industries. Hence, similar to entrepreneurship, biotechnology has been defined differently by scholars affiliated to either of the underlying fields. This contributes to the confusion about what a single unifying definition for the field in the early stages of development should be. However, 21st century biotechnology has been defined as "the use of cellular and biomolecular processes to solve problems or make useful products" [6]. 20th century biotechnology evolved from an emphasis on population problems and agriculture to a focus on areas such as pharmaceuticals, agricultural chemicals, food production, waste disposal and chemical manufacture. In the 21st century, biotechnology has assumed global importance in the areas of healthcare, environmental protection, agriculture, chemistry, and material science [6]. Biotechnology is capable of triggering disagreement and controversy as well as highlighting moral and ethical concerns that are difficult to resolve. These concerns include or arise from uneasiness over the fact that biotechnology is seen by some to "interfere with the workings of nature and creation", and that it might involve risk-taking for

commercial profit. However, in priority setting, all concerns must be clearly balanced, respecting ethical aspects but reflecting the actual and potential possibilities of increasing food supplies and alleviating hunger [15].

Many ethics-related issues are now being debated in the context of IPR legislation, but other issues remain unresolved. Since such issues are largely related to cultural background and to the level of public perception and awareness, decisions on the use of specific technologies should take into account socio-economic realities [17]. Members of the public have not been silent about ethical and moral issues involved in the granting patents on modern biotechnologies and related property rights. To encourage investing in the R & D of biotechnology, the patent regulations in some countries stipulated that varieties of animal, plant and microbe and their genetic materials and products, as well as production approaches are protected by patent [7].

Since the early 1980s, for example, the United States PTO (Patent and Trademark Office) had awarded hundreds of patents for genetically engineered plants and recombinant DNA approaches to manipulate plants (Wolfgang, 1995). Some people believe that humans and other organisms are created by God. Some have argued that granting patents on genes or organisms represents the usurpation of the ownership rights of the Sovereign of the universe. So, patenting of genetically engineered animals and human genes, cells, and organs is ethically unacceptable to them (Stone, 1995). In addition, to fully protecting the interests of the biotechnological inventors, some countries often approved patent applications much wider breadth from hither to. For example, in October 1992, the US/PTO (Patent and Trademark Office) awarded a patent to a single company, Agracetus, for the rights to all forms of genetically engineered cotton. In March 1994, the European Patent Office (EPO) granted broad rights to Agracetus for all forms of genetically engineered soybean that produced foreign substances. The Roslin Institute of England also applied for the international patent for the cloned sheep “Dolly”, and requested that the protected breadth be mammals, include human being.

The patent was made known to the public in March 1997 and aroused a panic internationally. These patents with such broad application not only could force smaller companies out of biotechnological business, but also might reduce the biotechnological research activities in certain countries and fields (Stone, 1995a). The width of these patent rights granted has the capacity to create mega-monopolies. The patent system can also be used by some countries/individuals to usurp intellectual ownership of “native technologies”. For instance, the neem tree, known as the “blessed tree”, had been used by Indian farmers as a medicine for centuries. After conducting research on the tree’s properties, however, a US company patented a method of extracting

and stabilizing azadirachtin, a potent natural pesticide, from the neem tree. The patent could hurt Indian farmers because they could be forced to stop using the technology which they have been using for generations or pay royalties for its use (Wolfgang, 1995).

1.2. Public Perception of Biotechnology Business and Products

Modern biotechnology has been viewed by many as the frontier of the next revolution. It is a powerful tool that presents a range of potential environmental, social and economic benefits that demands rigorous oversight (Kamaldeen & Powell, 2000). However, because the advancement in biotechnology has been so rapid in the past ten years, it has been the object of an intense and divisive debate in advanced countries. Sagar, (2000) suggest that a major factor in the emergence of controversies surrounding biotechnology has been the neglect of the needs, interests and concerns of the primary stakeholders the commoners. Public perceptions, understanding and acceptance of GMOs can both promote and hamper commercial introduction and adoption of new technologies **[10]**.

There is a wide gap between how scientists and risk experts think about, define and evaluate risks compared to the lay public. The experts have lamented that the public reactions to scientific risk assessments as ignorance and irrational but researchers have shown that the public understanding of risk is driven by factors not taken into account by the experts (Slovic, 1993). According to Sandman (1987), the public generally pays too little attention to the hazardous nature of risks while experts usually completely ignore those factors which fuel consumer unrest or outrage. These are two very different starting points and not surprisingly, experts and consumers often rank the relative importance of various risks very differently (Sandman, 1987; Slovic, 1987). Scientists, in general, define risks in the language and procedures of science itself. They consider the nature of the harm that may occur, the probability that it will occur, and the number of people who may be affected. Most citizens, in contrast, seem less aware of the quantitative or probabilistic nature of a risk, and much more concerned with broader, qualitative whether the risks and benefits are fairly distributed, whether the risk can be controlled by the individual, whether a risk is necessary and unavoidable or whether there are safer alternatives, whether the risk is familiar or exotic, whether the risk is natural or technological in origin, and so forth **[18]**. People also judge risk according to their perception of its controlling agents: if these controlling agents have a track record independent regulatory bodies and the public policy process, then people magnify the perceived risks **[8,7]**.

Modern biotechnology has been classified as a complex emerging issue that exhibits high salience combined with limited knowledge on part of the public. Various studies have shown that consumer acceptance of modern biotechnology tend to be conditional and dependent on many factors. It has also been suggested by

social scientists that any complex object may be located in a variety of general classes where its evaluation may also be strongly affected by extraneous concerns [15] of secrecy, or they dominate supposedly.

2. Biotechnology Entrepreneurship in Developed Economies

In developed economies, the United States (US) leads the chart in biotechnology. The US has more companies, produces more viable products, employs more people, invests more in research and development, and earns more than all of Europe combined [11]. African continent had been left behind, because it was used by colonialization in trying to colonize the continent (The schools were only in position of graduating teachers, secretaries, administrators, mainly specializing on how to read and write with the retarded brains in the sides of technology and technological-know-how and until now no effort tangibly being rendered in ameliorating the situation by the leaders of this continent). The United States of America was the early-mover embracing biotechnology and actively encouraging the development of the industry decades before Europe took the same route. In 2010, the bioscience industry was estimated to have directly created 1.6 million jobs in the US and to be indirectly responsible for about 3.4 million jobs in total [5].

At an international seine, there is extensive interaction between the American, European and some Asian biotechnology industry through the big multinational biotechnology corporations in their attempt to dominate the developing and under developing nations and research scientist networks. At a governmental level, many European countries, and some Asian countries such as Japan, implement similar policy initiatives to America in order to fast-track their biotechnology industries leaving still behind the so called developing nations of mostly African. Policy initiatives almost the same to those of America has been confirmed in the biotechnology industries of; the United Kingdom, Germany and Japan [14] and Sweden (Nilsson, 2001) Finland [12]. The combination of American and European biotechnology industries, under the banner of developed economies, constitutes a near total domination of the entirety of the global biotechnology industry, leaving the developing economies with little or no impact positively; this is because they are the target markets of the whole exercise. It is difficult to make a direct comparison between the biotechnology industry in the developed and developing economies, except in cases such as the biofuel industry in Brazil and Nigeria owing to the general lack of empirical research and data, and the undeveloped nature of the industry in most developing economies. However, the GEM report provides a basis of comparison for general entrepreneurial activities across these two types of economies (Bosma *et al.*, 2010), which is assumed to provide a similar comparative basis for biotechnology entrepreneurship.

Bosma *et al*., (2010), categorized the national conditions in the development of biotechnology entrepreneurship trends of the developed economies under “innovation-driven”. For developed economies,

the basic requirements like; institutions, infrastructure, macroeconomic stability, health and primary education and efficiency enhancers (higher education and training, goods market efficiency, labor market efficiency, financial market sophistication, technological readiness and market size are in place and are maintained properly in the developed economies to that of developing nations' economies. According to them, the key focus is on the entrepreneurial conditions such as entrepreneurship education, government entrepreneurship programs, entrepreneurial finance, government, internal market openness, physical infrastructure for entrepreneurship, and cultural and social norms are the areas of concern between the developed and developing economies in which the developing countries leaderships are still not been oriented technologically and entrepreneurially and therefore not areas of their concern mostly.

3. Biotechnology Entrepreneurship in Developing Economies

In Nigeria with developing economy and any other in Africa and some Asian economies, biotechnology entrepreneurship holds the tantalising prospect significantly to raw or processing materials and or services delivery such as food security, improved agricultural input/output, sustainable environmental development practices, improved healthcare, job creation, poverty alleviation and economic development (Lawal, 2014). The achievement of all, or any, of these benefits depends on the national conditions that exist in the developing economies. The "bigger" economies of the developing world, such as BRIC (Brazil, Russia, India and China), South Africa and possibly Nigeria (Department of Science and Technology, 2001), may be in a better position to exploit the benefits of biotechnology in a globalised world, whether through technology transfer, innovative development of the industry, development of particular niches within the biotechnology industry or a combination of these and other options. These bigger economies represent a vital link between the developing and the developed economies as the basic requirements already exist in these economies.

Herrington, (2012) classified South Africa and Brazil as efficiency-driven and as such the key focus is on the efficiency enhancers such as higher education and training, goods market efficiency, labour market efficiency, financial market sophistication, technological readiness and market size. While, these efficiency enhancers are fundamental to the development of entrepreneurial culture in general, the developing economies still need to develop the entrepreneurial conditions necessary for an innovation-driven industry such as biotechnology (Bosma *et al*., 2010).

The global issues of human health, food security, renewable resources and environmental sustainability [4] that are addressed by biotechnological solutions are more prevalent in developing economies as are the issues of economic and social development, unemployment and weak global competitiveness. These issues

highlight the importance of understanding and developing entrepreneurship in general, and specifically biotechnology entrepreneurship, in the developing nations' economy (Nilsson, 2001).

4. International Concerns on Bio-safety and Related Socioeconomic Issues of Biotechnology

Many countries are taking socioeconomic issues arising from new biotechnology very seriously. For example, some member countries of the EU (Austria, Denmark, Sweden, and Finland) believe that the socioeconomic impacts should be specifically taken into account when drawing up bio safety regulations. The Norwegian Gene Technology Act required that, before deciding whether or not to grant a license or patent application, significant emphasis should be placed on whether the deliberate release of Living Modified Organisms (LMOs) represents a benefit to the community and a contribution to sustainable development (Crompton, 1998). For example, an organization in Europe call Mothers for Natural Law appealed for all genetically modified food be banned immediately, because genetic engineering is not some minor biotech development, but is a radical new technology that violates fundamental laws of nature (Golub, 1997).

After the cloned sheep "Dolly" was born in 1997, the issue of "cloned man" has aroused strong reactions all over the world and had huge impacts on the present ethical and moral values. For instance, how do we decide on the relatives of a cloned man? Will human cloning lead to the creation of second-class citizens and even to a revival of slavery (Shapiro, 1997)?

The UNEP's "International Technical Guidelines for Safety in Biotechnology" also draws attention to the importance of assessing the socioeconomic impacts of biotechnology. During the negotiation of the "International Bio Safety Protocol", socioeconomic impacts were one of areas given special attention by several participating countries. In general, developed countries possess a high level of biotechnological expertise, with greater ability to solve bio safety issues than developing countries. They are the exporters and beneficiaries of biotechnological products. Many developed countries involved in negotiations argued that the socioeconomic issues of biotechnological change were too complex for them to contribute constructively to the debate because of their relative ignorance, although the issues were important. They agreed there was an urgent need for socioeconomic issues to be studied exhaustively. It was agreed that it is appropriate for international bio safety legislation to take such issues into consideration, and the socioeconomic issues of biotechnology should be discussed alone in another global forum (Nilsson, 2001).

In contrast to developed countries, developing countries have low biotechnological capacities, with little ability to solve bio safety issues. They are the importers of biotechnology and potential victims of the adverse impacts of biotechnological products. As a result, some developing countries, such as India and

China, believe that socioeconomic issues raised by modern biotechnology were very important to all countries, especially for the developing countries endowed with rich genetic biodiversity. They insisted that socioeconomic issues taken into account as an essential part of international biosafety legislation, that public safety should be protected through suitable policies and regulations. In addition, measures should be taken to ensure that economic activity and the distribution of income are economic opportunities and are not impaired by monopolization of biotechnologies, and it is needed to control production of genetic material such as seeds and associated chemical and biological substances by some private enterprises. They also requested that the Contracting Parties to the Convention on Biological Diversity, who planned to produce with biotechnology a commodity that had been previously imported, should notify in advance the other Parties whose exports would be reduced. The notification should be made sufficiently in advance (at least seven years), to enable the latter to make alternative production plans. When the affected Parties are developing countries, the Parties that replaced the imported products by biotechnological products should provide the affected Parties with financial and technical aid (Liu & Xue, 1998). Thus, it can be seen that, not only can biotechnology produce enormous social and economic benefits, but it may also result in many serious socioeconomic problems.

Those problems are intensified because of the vastly different stages of biotechnological development developed and less developed countries and regions and because of the varied economic and political situation of many countries and regions. Biotechnology policies need to accommodate those differences. Because of divergent development and social status of countries, it will be difficult to obtain global consensus in the short term on biotechnology policies and the socioeconomic issues which should be taken into account in such policies.

5. Conclusion

Nigeria with developing economy and any other in Africa and some Asian economies, biotechnology entrepreneurship holds the tantalizing prospect significantly to raw or processing materials and or services delivery such as food security, improved agricultural input/output, sustainable environmental development practices, improved healthcare, job creation, poverty alleviation and economic development. The understanding of the dynamics of biotechnology entrepreneurship in these developing economies, especially in Africa where there is a lack of a developed venture capital industry, will aid the venture capitalists in understanding the peculiarities of the environment, the challenges and gaps, the role of the government and the opportunities that can be exploited. The absence of large biotechnology companies was highlighted as one of the gaps in such developing economies. Given the involvement of the large biotechnology companies

in major R and D; their role as cooperation partners, customer and competitor; and the availability of good research universities and skilled researchers in Africa, there is an opportunity for the large biotechnology companies to seek out collaboration opportunities.

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