

Harnessing the Revenue Potentials of Biotechnology by the Public and Private Sectors by Prioritizing Research and Expenditure

Dennis Chukwueloke Odeigah

Bio-resources Development Centre, National Biotechnology Development Agency, Abuja, Nigeria

Email address:

thinkwell07@yahoo.com

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Abstract: Biotechnology has been in existence for a long time, not too long after the creation of man. It serves to increase food production, improve healthcare, enhance the environment and atmosphere, and prevent global or isolated wars. Much has been studied and discovered about the science, but few progress has been made regarding its economics. This article or paper serves to highlight the economics or revenue that can be derived from practicing biotechnology, and enhancing its usage through the utilization of modern techniques by consulting secondary data to appraise results in the course of the research. The analysis mainly was to determine the secret towards making the biotechnology industry a profitable venture, while focusing on high demand areas or products, but nonetheless meeting the demands of the general populace out of empathy thus rendering the discipline a fair one and at the long run generally profitable. The survey revealed that biotechnology is a lucrative industry to be embarked upon by both public and private sectors. The following recommendations are proffered, that research and expenditure should be prioritized, while endeavouring to cover all areas out of empathy in order to enhance general public appreciability.

Keywords: Biotechnology, Selective Breeding, Bioengineering, Hybridization, Anti-biotechnologists, Economics, Biofuels

1. Introduction

Not normally what primely comes to mind, numerous forms of mankind-derived agriculture obviously fit the wide definition of “using a biotechnological system to manufacture products.” Certainly, the cultivation of plants may be seen as the earliest biotechnological enterprise.

Agriculture has been theorized to have become the dominant way of producing food since the Neolithic Revolution. Via early biotechnology, the earliest farmers chose and bred the best suited crops, having the greatest yields, to produce enough food to contain a growing population. As crops and fields became increasingly large and abstruse to maintain, it was discovered that specific organisms and their by-products could effectively fertilize, restore nitrogen, and control pests. In the entire history of agriculture, farmers have inadvertently changed the genetics of their crops through introducing them to new environments

and breeding them with other plants – one of the prime forms of biotechnology.

All these processes were also included in early fermentation of beer [1]. They were introduced in early Mesopotamia, Egypt, China and India, and still use identical basic biological methods. In brewing, malted grains containing enzymes transform starch from grains into sugar and then augmenting specific yeasts to make beer. In this process, carbohydrates in the grains were disintegrated into alcohols such as ethanol. Later other cultures made the process of lactic acid fermentation which permitted the fermentation and preservation of other forms of food, such as soy sauce. Fermentation was as well utilized in this time period to produce leavened bread. Albeit, the process of fermentation was not fully comprehended until Louis Pasteur’s work in 1857, it is still the prime use of biotechnology to transform a food source into another form.

Prior to the time of Charles Darwin’s work and life, animal

and plant scientists had already utilized selective breeding. Darwin augmented to that body of work with his scientific observations concerning the ability of science to transform species. All these accounts contributed to Darwin's theory of natural selection [2].

For thousands of years, human beings have utilized selective breeding to enhance production of crops and livestock to use them for food. In selective breeding, organisms with desirable characteristics are mated to produce offspring with the same characteristics. For example, this technique was utilized with corn to produce the largest and sweetest crops [3].

In early twentieth century, scientists gained a greater understanding of microbiology and explored ways of making specific products. In 1917, Chaim Weizman first used a pure microbiological culture in an industrial process, that of manufacturing corn starch using *Clostridium acetobutylicum*, to make acetone, which the United Kingdom desperately needed to make explosives during World War I [4].

Biotechnology has also led to the development of antibiotics. In 1928, Alexander Fleming discovered the mold *Penicillium*. His work gave rise to the purification of the antibiotic compound formed by the mold by Howard Florey, Ernst Boris Chain and Norman Heatley – to form what we today know as penicillin. In 1940, penicillin became available for medicinal utilization to treat bacterial infections in humans [3].

The field of modern biotechnology is generally thought of as having been born in 1971 when Paul Berg's (Stanford University, USA) experiments in gene splicing had early success. Herbert W. Boyer (University of California at San Francisco, USA) and Stanley N. Cohen (Stanford University, USA) significantly advanced the new technology in 1972 by transferring genetic material into a bacterium, such that the imported material would be reproduced.



Figure 1. Brewing was an early application of biotechnology.

2. Objectives of Study

To prove that biotechnology creates personal wealth and

expands national government revenues.

3. What Is Biotechnology

The use of living systems and organisms to develop or make products, or “any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use” is known as Biotechnology (UN Convention of Biological Diversity, Art. 2). Depending on the tools and applications, it often overlaps with the fields of bioengineering, biomedical engineering, biomanufacturing, molecular engineering, etc.

For thousands of years, humankind has used biotechnology in agriculture, food production, and medicine. The term is largely believed to have been coined in 1919 by Hungarian engineer Karoly Ereky. Since late 20th and early 21st century, biotechnology has expanded to include new and diverse sciences such as genomics, recombinant gene techniques, applied immunology, and development of pharmaceutical therapies and diagnostic tests.

The wide concept of “biotech” or “biotechnology” surrounds a wide range of procedures for modifying living organisms according to human purposes, revisiting domestication of animals, cultivation of the plants, and “enhancements” to these through breeding programs that employ artificial selection and hybridization.

The field of biotechnology has applications in four major industrial areas, including health care (medical), crop production, and agriculture, non-food (industrial) uses of crops and other products (e.g. biodegradable plastics, vegetable oil, biofuels), and environmental uses.

For example, one application of biotechnology is the directed use of organisms for the manufacture of organic products (examples include beer and milk products). Another example is utilizing naturally present bacteria by the mining industry in bioleaching. Biotechnology is also used to recycle, treat waste, clean up sites contaminated by industrial activities – bioremediation – and to produce biological weapons.

In medicine, modern biotechnology finds applications in areas such as pharmaceutical drug discovery and production, pharmacogenomics, and genetic testing or genetic screening.

Biotechnology has contributed to the discovery and manufacturing of traditional small molecule pharmaceutical drugs as well as drugs that are the product of biotechnology – biopharmaceuticals.

Genetically modified crops or biotech crops are plants utilized in agriculture, the DNA of which has been modified with genetic engineering techniques. In most cases the aim is to introduce a new trait to the plant which does not naturally occur in the species.

Farmers have widely adopted GM technology. Between 1996 and 2011, the total surface of land cultivated with GM crops had expanded by a factor of 94, from 17,000 square kilometres (4,200,000 acres) to 1.6mn km² (395mn acres) [5]. 10% of the world's crop lands were planted with GM crops in 2010 [5]. As of 2011, 11 different transgenic crops

were grown commercially on 395mn acres (160mn hectares) in 29 countries such as the USA, Brazil, Argentina, India, Canada, China, Paraguay, Pakistan, South Africa, Uruguay, Bolivia, /Australia, Philippines, Myanmar, Burkina Faso, Mexico and Spain.

GM foods are foods produced from organisms that have experienced specific changes introduced into their DNA with the methods of genetic engineering. These techniques have permitted for the introduction of new crop traits as well as a far greater control over a food's genetic structure than previously afforded by methods such as selective breeding and mutation breeding [6].

Commercial sale of GM foods began in 1994, when Calgene first marketed its Flavr Savr delayed ripening tomato. GM livestock have also been experimentally developed, although as of November 2013 none are currently on the market.

There is a scientific consensus [7-9] that currently available food derived from GM crops poses no greater risk to human health than conventional food [10], but that each GM food needs to be tested on a case-by-case basis before introduction [11].

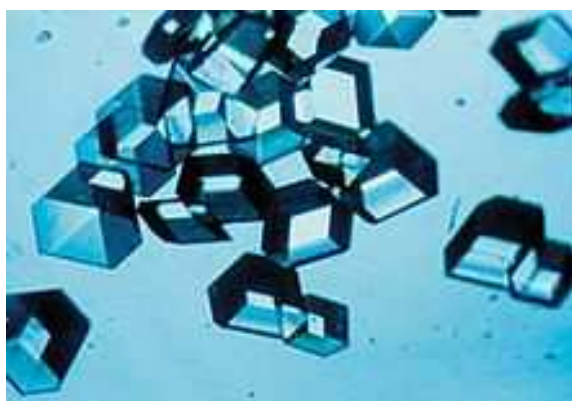


Figure 2. *Insulin crystals.*

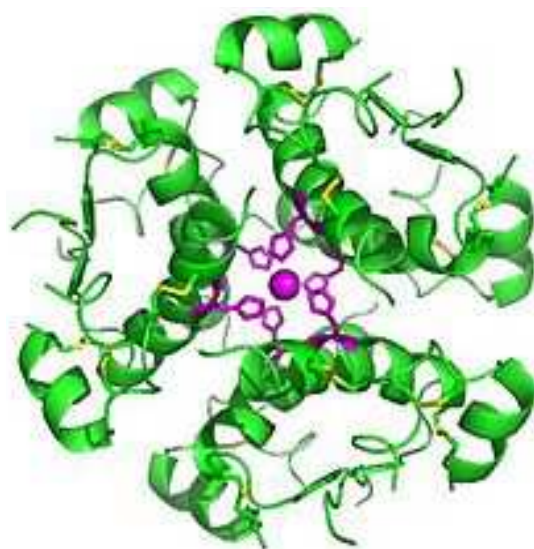


Figure 3. *Computer-generated image of insulin hexamers highlighting the threefold symmetry, the zinc ions holding it together, and the histidine residues involved in zinc binding.*

The environment can be affected by biotechnologies, both positively and adversely. Vallero and others have argued that the disparity between beneficial biotechnology, e.g. bioremediation to clean up an oil spill or hazard chemical leak, versus the adverse effects stemming from biotechnological enterprises, e.g. flow of genetic material from transgenic organisms into wild strains, can be seen as applications and implications, respectively.

4. Anti-Biotechnologists

On January 24, 2000, more than 600 scientists from around the world signed a “Declaration in Support of Agricultural Biotechnology,” which was released on stated date, coinciding with UN negotiations on a Biosafety Protocol. The scientific community felt it necessary to counteract the baseless attacks so often being made on biotechnology and genetically modified foods, says C. S. Prakash, a biology professor at Tuskegee University in the United States, and organizer of the declaration. Biotechnology is a potent and valuable tool that can assist to render foods more productive and nutritious, he added. Also, contrary to anti-biotech activists, they can even advance environmental goals such as biodiversity.

Farmers have been genetically modifying crop plants for centuries with more traditional methods of hybridization and selection. According to the declaration, utilizing biotechnology to modify plants today does not pose any new or greater risks than those more traditional methods posed. Due to the fact that the newer genetic tools are more precise, they may even be safer. Their greater productivity permits farmers to grow more food on less land with less synthetic pesticides and herbicides, ultimately protecting wildlife and habitat, added Prakash.

Genetically modified plants can also benefit local and regional agriculture in the developing world, the key to addressing both hunger and low income. Anti-biotechnology activists accuse scientists of “playing God” by genetically improving crops, but it is those so-called environmentalists who are really playing God, not with genes but with the lives of poor and hungry people, said Prakash.

Dr. Prakash, who serves as Director of Tuskegee University’s Center for Plant Biotechnology Research, wrote the Declaration with the help of several colleagues, and began collecting signatures on January 19.

Both the declaration text and a list of signatures, which will be updated periodically, can be found on the AgBioWorld website at www.AgBioWorld.org.

5. Economics of Biotechnology

The commercial viability of a biotechnology industry was significantly expanded on June 16, 1980, when the United States Supreme Court ruled that a genetically modified microorganism could be patented in the case of *Diamond v. Chakrabarty* [12]. Indian-born Ananda Chakrabarty, working for General Electric, had modified a bacterium of the

Pseudomonas genus, capable of breaking down crude oil, which he proposed to use in treating oil spills. Chakrabarty's work did not involve gene manipulation but rather the transfer of entire organelles between strains of the *Pseudomonas* bacterium.

Revenue in the industry has grown ever since discovery by a considerable amount. Other factors influencing the biotechnology sector's success are enhanced intellectual property rights legislation – and enforcement – globally, as well as strengthened demand for medical and pharmaceutical products to cope with an ageing, and ailing, U.S. population.

Rising demand for Biofuels is expected to be good news for the biotechnology sector, with the Department of Energy estimating ethanol usage could reduce U.S. petroleum-derived fuel consumption by up to 30% by 2030. The biotechnology sector has permitted the U.S. farming industry to rapidly increase its supply of corn and soybeans – the main inputs into Biofuels – by developing genetically modified seeds which are resistant to pests and drought. By boosting farm productivity, biotechnology plays a crucial role in ensuring that biofuel production targets are fulfilled.

6. Conclusion

Biotechnology is a profitable field. It has numerous positive applications, many persons and researchers are interested in delving into the field because of its lucrativity and health it can provide to mankind. However, in a world of scarce resources, it is necessary that prioritization is exercised in research and expenditure in order to achieve positive net-profits. Nonetheless, out of empathy, it is vital that all areas are covered to achieve general public appreciability and the elongation of its relevance in the long run.

Caution though should be exercised not to engage in debatable areas that are quite controversial like cloning.

Jon Huntsman, Jr. saw into the future, “My sense is that we're ready for another industrial revolution in this country. The great minds and innovators of Silicon Valley would come through China and say, The pipeline is full of ideas –

there's personalized medicine, biotechnology, new forms to power ourselves, clean energy, etc., etc.”

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