Analysis of the Impact of Genetic Engineering on China's Economy

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Abstract: At the genetic level, a method similar to engineering design is adopted, designed according to human needs, and then a new biological strain with a certain new trait is created according to the design scheme, and can be stably inherited to future generations. The birth of genetic engineering has played an important role and contribution to the study of biology and has had a great impact on human society. Genetic engineering has brought us certain benefits in terms of genetically modified crops, animals, microbes and medicine. Based on this, this paper firstly describes the content and market prospects of genetic engineering, and then analyzes the impact of genetic engineering on China's economy in four aspects.

1. Introduction

The research of genetic engineering has made major breakthroughs and progress in the world at home and abroad. The genetic engineering technology developed from the 1970s has become the core content of biotechnology after years of progress and development [1]. Genetic engineering is very important in the large-scale fermentation of engineering products for "downstream technology", but "upstream technology" is essential for the development of genetic engineering products [2]. Genetic engineering has a huge impact on the economic development of our country in many aspects such as agricultural production, health care, light industrial food and environmental sanitation [3]. The development of genetic engineering allows people to artificially transform a certain trait of a certain creature according to their own subjective wishes. Genetic engineering technology has made rapid progress and achieved many remarkable achievements.

2. Genetic Engineering Concept

Genetic engineering, also known as DNA recombination technology and genetic recombination technology, is a technological science emerging in the early 1970s. It is an extremely complex high-tech biotechnology that utilizes the theories and methods of modern genetics and molecular biology. It is necessary to artificially modify the structure and composition of the biological genome by using DNA recombination technology, and send the DNA recombinant into the recipient cell to replicate, transcribe and translate in the recipient cell, thereby changing the structure and function of the organism. It can effectively express the protein or human beneficial biological traits that humans need. This ability to put genes from any organism into unrelated new host biological cells across the natural species barrier is a fundamental feature of genetic engineering technology that distinguishes it from other technologies. Genetic engineering has brought profound changes to the research of life sciences. At present, scientists have completed the complete sequencing of genomes of various organelles. Genetic engineering has a wide range of applications and can open up new avenues for industrial and agricultural production, medical and health, and environmental protection.

3. Principle of Genetic Engineering

The basic principle of genetic engineering is to cleave and recombine DNA from different sources in vitro to form a mosaic DNA molecule, which is then introduced into the host cell to be amplified and expressed, so that the host cell acquires new genetic characteristics and forms a new gene product. It has 3 basic steps:

1) Isolation or preparation of daily genes or DNA fragments from suitable materials.

2) The tomb or DNA fragment of the target is connected to the vector to form a recombinant DNA molecule.

3) Recombinant DNA is introduced into the host cell, where it is amplified and expressed.

The biological characteristics of different kinds of organisms are different, and their genetic engineering is inevitably different in operation and specific technology, but the core of the technology is the recombination of DNA, that is, the use of a series of DNA restriction enzymes, ligase and other molecular operations. A tool that cuts a target gene or a particular DNA fragment from a biological DNA strand and then attaches it to the recipient's DNA strand according to design requirements.

4. Major Events In Genetic Engineering

From 1860 to 1870, the Austrian scholar Mendel proposed the concept of genetic factors based on the pea hybrid experiment and summarized Mendel's law of inheritance [4]. In 1909, Danish botanist and geneticist Johnson first proposed the term "gene" to express Mendel's concept of genetic factors. In 1944, three American scientists isolated the bacterial DNA (deoxyribonucleic acid) and found that DNA is a molecule carrying life genetic material. In 1953, American Watson and British Crick proposed a double helix model of DNA molecules through experiments. In 1969, scientists successfully isolated the first gene. In 1980, scientists first developed the world's first transgenic mouse for transgenic animals. In 1983, scientists first developed the world's first genetically modified plant genetically modified tobacco. In 1988, K. Mullis invented the PCR technology. In October 1990, the International Human Genome Project, known as the Life Science Apollo Moon Landing Program, was launched. In 1998, a group of scientists set up Celera Genetics in Rockwell, USA, to compete with the International Human Genome Project. In December 1998, the determination of a complete genomic sequence of a small nematode was completed. This is the first time that scientists have mapped the genome of a multicellular animal. In September 1999, China was approved to join the Human Genome Project, which is responsible for measuring 1% of the entire human genome. China is the sixth participating country in the International Human Genome Project after the United States, Britain, Japan, Germany and France. It is also the only developing country participating in this program. At the end of April 2000, Chinese scientists completed the working framework of 1% of the human genome in accordance with the deployment of the International Human Genome Project. In 2010, Provenge, the first therapeutic vaccine for prostate cancer, was launched.

5. The Impact of Genetic Engineering Technology on The Chinese Economy

5.1 Economic Significance of Developing Transgenic Agriculture

Considering the most basic input-output model in economics, it is imperative to develop GM agriculture. As an advanced science and technology, GM technology is bound to bring about rapid development of productivity. Moreover, considerable investment in GM crops. The rate of return also justifies this. This extremely high return on investment can be reflected in the technical operation of GM crops in the world's major countries. We can also get some inspiration: the development of GM crops in the way of company operations is a constructive road. Products developed by high-tech companies with certain economic strength and technical strength to develop GM technology, from the perspective of the individual micro-individual, on the one hand, due to limited funding and technical strength, the choice of investment projects will also be more cautious, which is conducive to the development of projects with higher returns. On the other hand, in the form of company operations, it is more conducive to the use of market regulation mechanisms to achieve the application of genetic modification technology to maximize profits and benefits. At the same time, individual companies are weak and have a common direction. It can form different forms of alliance. After all, the interest is the lifeline of the company. It can also be added to the risk fund investment factor, because venture capital will have a strong interest in this promising and promising industry. It is possible to consider the development of transgenic technology by means of the financing of the second board market such as NASDAQ. At present, there is no second board market in mainland China, and the development of such projects still has time to wait for various reasons, so it is currently for China. It is more practicable to use international investment funds to be more secure. The government should play a more important role in the relationship between technology and production. The most important thing is to do a good job of guiding the macro. From the perspective of the ripple effect, genetically modified crops as the vanguard of the agricultural industry, the enormous power caused by the industries involved in it is also foreseeable. In this way, the development needs of the entire society, especially for developing countries like China, the development prospects of genetically modified agriculture are infinite.

5.1.1 Genetically modified crops

The transgenic plants in foreign countries have developed more mature than domestic ones. However, under the support of the national "863" high-tech research and development plan and the national science and technology research plan, the research and development of transgenic plants in China have made remarkable progress, and some studies have reached international advanced level [5]. At present, China has plant genetic engineering research projects such as plant resistance to insect genetic engineering, disease resistance genetic engineering, plant stress resistance genetic engineering, plant quality improvement genetic engineering, plant chloroplast genetic engineering, plant bioreactors [6]. Moreover, in 2001, the commercial planting area of genetically modified plants in the world reached 52.6 million hectares, of which China's planting area was 1.5 million hectares, three times that of 2000, becoming the fastest growing country for GM crops [7].

Through a series of studies, they show that GM rice can improve agricultural income. The commercialization of GM rice can also bring huge benefits to China's macro economy, which will bring about $3 billion in benefits to producers and consumers every year [8]. If the adoption rate of GM rice in China reaches 70% in 2015, the total welfare will increase by 2.65 billion US dollars; even if the adoption rate is only 50%, the total welfare will reach 1.98 billion US dollars [9]. Considering the impact of the commercialization of genetically modified rice on China's trade, even if foreign countries adopt technical barriers to all of China's genetically modified rice, due to the increase in the production of genetically modified rice, the increase in the export of other agricultural products and non-agricultural products caused by the replacement of rice planting area by other agricultural products will increase China's total trade balance by 390 million yuan [10]. As of 2018, 1917 million hectares of GM crops were planted in 26 countries, an increase of 1.9 million hectares from the 189.8 million hectares in 2017, and an increase of 1% [11]. The average application rate of GM crops in the world's top five GM crop growing countries (average application rates of soybeans, corn and rapeseed) is growing, close to saturation, including 93.3% in the US, 93% in Brazil, 100% in Argentina, 92.5% in Canada, and 95% in India [12].

5.1.2 Transgenic animals

The application and industrialization of transgenic animals are rapid. At present, there are 43 companies with animal genetic modification technology as the core, which has become the pillar industry in the 21st century biotechnology field [13]. The global sales of animal biotechnology products from 1999 to 2010 will reach 110 billion dollars, of which 7.5 billion will come from genetically modified animal species [14].

In 2006, the world's first genetically engineered protein drug, recombinant human antithrombin III

(ATryn), produced in the world using a transgenic animal mammary gland bioreactor, was approved for marketing and sold worldwide, demonstrating the use of animal mammary gland bioreactors to produce humans pharmaceutical proteins [15]. The success of China's first batch of genetically modified cloned buffalo in 2010 is of great significance for the development of new high-efficiency buffalo mammary bioreactors and the cultivation of new high-yield transgenic buffalo breeds.

Transgenic animals can be used in human disease models, animal organs used to produce human organ transplants, as bioreactor production drugs and nutraceuticals, and their use in medicine has greatly improved China's economic benefits.

5.2 Impact on the Medical Economy

5.2.1 Gene therapy

Gene therapy refers to the use of genetic engineering techniques to transfer normal genes into cells of patients, to replace diseased genes, thereby expressing the lack of products, or by shutting down or reducing abnormally expressed genes. At present, more than 6,500 genetic diseases have been discovered, of which about 3,000 are caused by single gene defects. Therefore, genetic diseases are the main target of gene therapy.

The latest advancement in gene therapy is the immunization of gene therapy with gene gun technology. The method is to introduce a specific DNA into the muscle, liver, spleen, intestine and skin of mice with improved gene gun technology for successful expression. This success indicates that in the future, people may use gene guns to deliver drugs to specific parts of the human body to replace traditional vaccinations and use gene gun technology to treat genetic diseases.

Currently, scientists are studying fetal gene therapy. If the current experimental efficacy is further confirmed, it is possible to extend fetal gene therapy to other genetic diseases to prevent the birth of newborns with genetic disorders, thereby fundamentally improving the health of future generations. Genetic diseases are caused by the wrong genes of the parents. Genetic screening can quickly diagnose errors in genetic code; gene therapy is the use of genetic engineering techniques to treat such diseases. Prenatal genetic screening can diagnose whether a fetus has a genetic disease. This screening method can even diagnose in vitro fertilized embryos, as early as two-day-old tube embryos in eight cell stages. The practice is to take one of the cells out, extract the DNA, check whether the gene is normal, and then decide whether to implant the embryo into the mother's uterus. Fetal sex can also be detected at the same time.

At present, the medical profession is clinically testing gene therapy for a variety of genetic diseases. The earliest use of gene therapy is a kind of congenital immunodeficiency, also known as bubble-boy disease. Because of the defect of the adenosine deaminase gene, the bone marrow cannot make normal white blood cells to exert immune function, and must live in the air completely isolated from the outside world. The latest treatment is to isolate white blood cells from the patient's bone marrow, and connect the normal enzyme gene to the retrovirus that is not toxic.

Another convenient treatment is also in the experiment, where one in every 2,000 people in the UK suffers from cystic fibrosis. The patient is unable to create a protein that forms a chloride channel in the cell membrane. This protein is distributed on the membrane of secretory cells, controlling the transport of chloride ions and making the mucus unobstructed. Due to the lack of this protein in the patient's body, the accumulation of mucus in the body blocks the passage of the lungs and even inflammatory death. In order to treat this disease, a new method is being developed to add a normal gene to a spray, and the patient can inject the gene into the lung cells to produce protein for therapeutic purposes.

But extensive genetic screening will cause a series of social problems. If someone accepts a genetic screening and finds that he will die of a disease at a certain age, it will definitely change his outlook on life. Although genetic screening can help doctors treat patients more effectively and earlier, it may hinder his future life employment. For example, life insurance companies will require customers to provide family health data, such as heart disease, diabetes, breast cancer, etc., and set higher premiums for high-risk family members. Insurance companies can predict the life expectancy of customers by genetic screening data. These people may therefore not receive insurance care, or they may be dismissed by the company owner early.

5.2.2 Genetic screening

Genetic screening does not alter a person's genetic makeup, but gene therapy will. Scientists are working to change the genetics of genetic patients and send good genes into them to correct mistakes. Because this is a fundamental problem in the operation of life, you must be extra careful. First, medical and non-medical behavior must be classified. The purpose of medical behavior is to treat diseases, and non-medical people want to improve their height and wisdom. Choosing the sex of the fetus is also a non-medical behavior and cannot be accepted. However, in the case of certain sexually transmitted diseases, choosing the sex of the fetus is an acceptable medical behavior. Another thing to distinguish is the genetic manipulation of somatic cell or germ-line cell. The genetic manipulation of somatic cells affects only the body's somatic cells and does not affect the offspring. However, the genetic manipulation of germ cells such as eggs and sperm directly affects the offspring. Currently, genetic engineering is prohibited from being directly used on germ cells.

5.2.3 Genetic engineering drugs

Biomedicine mainly includes the development of pharmaceutical products such as blood products, vaccines, diagnostics, and monoclonal antibodies. In 2016, China's blood products industry sales revenue was 29.693 billion yuan, accounting for 9%, while the proportion of diagnosis and vaccine was 10.39% and 7.97% [16]. The Chinese biopharmaceutical market increased from 8.7% of China's overall pharmaceutical market in 2013 to 15.3% in 2017. In 2017, the market size of China's biopharmaceutical industry was 218.5 billion yuan. In 2018, the market size of China's biomedical industry exceeded 250 billion yuan. As can be seen from the forecast in Figure 2 below, the market share of biopharmaceuticals has increased year by year, and the growth rate has increased year by year.

Many pharmaceutical products are produced from biological tissues. Limited production by material sources is often very expensive. Microorganisms grow rapidly, are easy to control, and are suitable for large-scale industrial production. If the genes for biosynthesis of the corresponding drug components are introduced into the microbial cells to produce the corresponding drugs, not only can the yield problem be solved, but also the production cost can be greatly reduced. At present, the genetic engineering application industry led by genetic engineering drugs has become one of the fastest growing industries in the world, and its development prospects are very broad. Genetic engineering drugs mainly include cytokines, antibodies, vaccines, hormones and oligonucleotide drugs [17]. They play an important role in preventing human cancer, cardiovascular diseases, genetic diseases, diabetes, various infectious diseases including AIDS, and rheumatoid diseases. In many fields, especially difficult diseases, genetic engineering drugs play a difficult role in traditional chemical drugs.

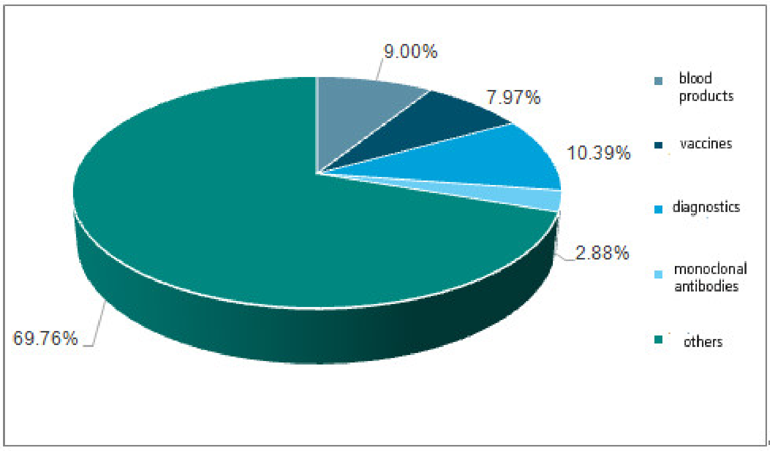

Figure 1. Analysis of the proportion of biomedical segments in 2016

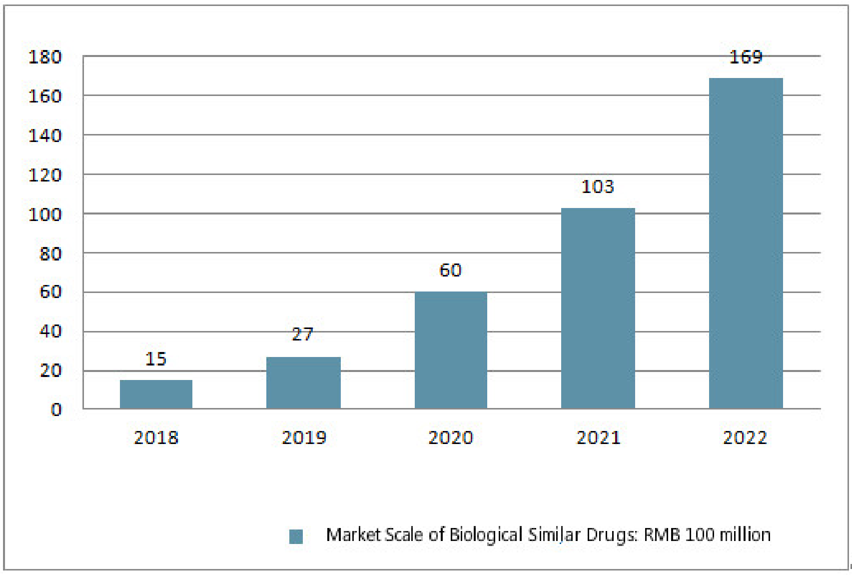

Figure 2. Forecast of the scale of China's biosimilar drug market in 2018-2022

In 1982, Lilly Company of the United States first put recombinant insulin on the market, marking the birth of the world's first genetic engineering drug [18]. Genetic engineering drugs have created rich returns for many companies in the United States, and have achieved enormous economic and social benefits. Europe has also made rapid progress in the development of genetic engineering drugs. The demand for biological products in China, France, Germany and Russia is huge. In the past few years, Chinese companies have been able to maintain an average annual growth rate of more than 15%, and the growth rate of sales in recent years has been speed up the trend.

According to statistics, the total sales revenue of domestic biological products in 2005 was 15.74 billion yuan, and the total sales profit was 3.87 billion yuan [19]. It is estimated that by 2006, the total output value of the biotechnology industry will reach 40 billion to 50 billion yuan, and by 2015 the total output value will reach 110 billion to 130 billion yuan. The market size of China's biosimilar drugs is still relatively small in recent years. The market growth will accelerate from 2017 to 2022, with an average annual compound growth rate of 70.9% and reach RMB16.9 billion in 2022 [20]. As can be seen from Table 1 below, the biopharmaceutical industry has higher returns than other industries, which also shows that China has made great achievements in the development and production of genetic engineering drugs, and even caught up with and surpassed the United States in certain areas of life sciences technology and industry. The research and development of genetic engineering drugs in China started late. It was not until the early 1970s that DNA recombination technology was applied to medicine. In 1989, China approved the first genetic engineering drug produced in China, recombinant human interferon recombinant human interferon α2b, which marked a breakthrough in genetic engineering drugs produced in China.

Table 1 Biopharmaceutical industry revenues compared with other industries

	Medical biology	real estate	Bank class	Steel	Broker
Number of sector index shares	186	158	19	47	22
Average earnings per share	0.26	0.17	0.37	0.03	0.18
Average net assets per share	4.28	3.27	3.30	3.87	5.24
Average return on equity	6.07%	5.29%	11.29%	0.79%	3.40%
Average undistributed profit	1.359	1.212	1.038	0.911	1.151

The United States invests up to $1 billion a year in the manufacture of genetically engineered drugs. It has also developed corresponding preferential policies to stimulate development, and its results are also very prominent. Japan has also invested a large amount of money in the research and development of genetic engineering drugs, and its genetic recombination products have reached sales of 421.5 billion yen in 1994. China's "863" plan "7th Five-Year Plan" and "Eighth Five-Year Plan" projects have also made encouraging progress. China's genetic engineering drugs and vaccines have also been put on the market. By 1990, the output value of genetic engineering drugs in China reached 1.8 billion yuan, of which the profit was 500 million yuan. The use of genetic engineering techniques to develop new therapeutic drugs is currently the most active and fastest growing field. Bioengineered drugs will be the backbone of the 21st century pharmaceutical industry.

5.2.4 Gene chip

The prototype of gene chip (also known as DNA chip, biochip) was proposed in the mid-1980s. The sequencing principle of the gene chip is a hybridization sequencing method in which a probe of a known octanucleotide is immobilized on the surface of a substrate by performing nucleic acid sequence determination by hybridization with a set of nucleic acid probes of known sequences. When the fluorescently labeled nucleic acid sequence TATGCAATCTAG is present in the solution to produce a complementary match with the nucleic acid probe at the corresponding position on the gene chip, a set of fully complementary probe sequences is obtained by determining the position of the probe with the strongest fluorescence intensity. According to this, the sequence of the target nucleic acid can be recombined.

At present, the preparation technology of foreign high-density gene chips is mainly in-situ synthesis. This technology has been patented by the US affyinetnx company. Therefore, high-density chips are only produced by the company. Most other companies use the preparation techniques of medium and low density gene chips such as printing, printing and spotting. This makes affyinetnx a leader in the field of gene chips, and its stock has been listed on the NAS-DAQ in the United States, showing strong growth. According to the "Huasheng Daily" reported on August 16, 2000, China has the ability to produce 2 million gene chips per year. United Gene Technology Co., Ltd. can integrate 175,000 gene probes into five sets of chips with a density of about 6000 per square centimeter, and the cost is only about 1/8 of the cost of similar products on the international market.

5.3 Impact on the Industrial Economy

The environmental pollution caused by industrial development and other human factors has far exceeded the purification ability of microorganisms in nature, and has become a matter of great concern. Genetic engineering can be used for environmental monitoring, as well as for the purification of contaminated environments, and attempts to recover and utilize industrial waste through genetic engineering. Genetic engineering technology enhances the ability of microorganisms to purify the environment. The genetically engineered bacteria that have been developed include ddt bacteria for purifying pesticides, dyes for degrading water, organochlorine benzenes and chlorophenols in the environment, engineering bacteria for polychlorinated biphenyls, and engineering bacteria for degrading tnt explosives in soil. Genetically engineered bacteria and plants used to adsorb inorganic toxic compounds (lead, mercury, cadmium, etc.).

6. Conclusion

China is a large country with more than 1.3 billion people. In terms of population and health, agriculture and environmental protection, we face enormous challenges. To improve people's health, quality of life and sustainable development of agriculture and resources, China must rely on the contribution of life sciences and biotechnology. Genetic engineering is the core technology for improving biotechnology. In 2007, sales of genetic engineering drugs and vaccines reached 3.03 billion yuan, and in 2008 it increased to 4.25 billion yuan, an average annual increase of 49.42%. This shows that China's bio-economy has been developing at a very rapid pace recently, and China's genetic engineering is still at a development stage. At present, China's science and technology conversion rate is only 15%, and the contribution of technological progress to economic growth is only 29%, far lower than the level of developed countries (60%-80%). Genetic engineering is a huge economic chain in the bio-economy, so we must actively promote the industrialization of biotechnology to improve the economic benefits of genetic engineering in China.

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