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Review of China's Agricultural Science & Technology Development During 2011-2015

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Introduction

Since the12th Five-year Plan, especially the 18th National Congress of the Communist Party of China, the Ministry of Science and Technology has joined hands with related departments and local governments to facilitate implementation of the innovation-driven development strategy and develop innovative agricultural science & technology systems and mechanisms. These efforts have produced remarkable results in advancing China's agricultural science and technology. During the 2011-2015 period, China has made significant headway in agricultural science and technology, which contributed to more than 56% of economic growth in agriculture in 2015, versus 52% in 2010. China's ability to pursue innovation has also improved substantially. Thanks to the great progress in agricultural science and technology, China has witnessed a significant increase in land output,

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resource utilization rate and labor productivity, and ensured continuous growth in food production and supply. The promotion of mass entrepreneurship and innovation, the integrated development of the primary, secondary and tertiary industries, as well as the technological advance in biological breeding, agricultural machinery, intelligent agriculture and food production are making remarkable contribution to transformation of agricultural development and modernization of the agricultural industry.

(Source: Science and Technology Daily, May 31, 2016)

I. Major Progress in Scientific Research

China's innovation capabilities in agricultural science have been substantially strengthened in the past five years. Several remarkable discoveries were made by Chinese scientists on prominent issues like resource collection and gene mining, disaster prevention & control, the agricultural ecosystem and its evolution. Relevant papers were published on prestigious international journals such as Nature and Science. Such accomplishments had significant impacts on the development of related disciplines.

National system for germplasm collection and conservation

China has established a sound national system for germplasm collection and conservation. The size of conservation is the world's second largest. China has also built the world's largest somatic cell bank of livestock and poultry, a germplasm bank for special animals and a bank of agricultural microbiological resources. The production of a huge amount of new germplasm resources is enabling China to change from a country with a large number of germplasm resources to a country good at utilizing such resources.

Bioreactor of rice albuminous cell and its application

The new technology resolved problems related to the recombinant human serum albumin of paddy rice such as low expression, complicated purification process and difficulties in mass production. The expression quantity of human serum albumin in rice seed reaches 0.96% of the dry weight of coarse rice. That is to say, rice yield per mu (667 square meters) of arable land can produce an equal amount of human serum albumin as from 275 people each donating 200ml of blood plasma. The new technology has brought revolutionary changes to the biopharmaceutical industry and indicates China has become an international leader in the research and application of plant bioreactor.

Explaining strigolactones' signaling pathways in the regulation of rice tillering

Chinese researchers made groundbreaking discoveries in the research of the molecular mechanism through which strigolactones (SLs) carry out signal transduction. They firstly revealed that D53 acts as a repressor of the SL signaling pathway and works together with transcription repressors to repress the expression of downstream genes and block the signaling pathway. SLs induce D53 degradation by the proteasome and abrogate its activity in promoting axillary bud outgrowth. The Nature magazine spoke highly of the theoretical significance and potential application value of the research which was credited as one of the top 10 scientific breakthroughs in China in 2014.

Draft genome sequence of aegilops tauschii

Chinese scientists became the first in the world to complete the sequencing of the aegilops tauschii genome - the D genome donor of common wheat, putting an end to the absence of assembled genome sequence of wheat. The study was published on the Nature magazine, suggesting China is at the forefront of this area.

Sequencing oyster genome and whole-genome selective breeding

Chinese researchers drew a genome sequence map of oyster species, marking a pioneering genomic study

of lophotrochozoa. The research result was published in the Nature. Chinese scientists also made remarkable breakthroughs in genomic technologies and developed new genotyping techniques and algorithms. The research finding was published in the Nature Methods. China established the world's first analytical system for whole-genome breeding and cultivated two new varieties.

Draft genome sequence of moso bamboo

The draft genome sequence of moso bamboo was the first of its kind initiated and completed by Chinese scientists. The research explained the evolutionary history of moso bamboo dating back 50 million years ago; obtained 31,987 highly-reliable genes and their expression profiles. Such findings facilitated the study into the genomic functions, molecular breeding and evolution of gramineous plants.

The potential of animal influenza virus in causing large-scale human influenza and its genetic mechanism

Chinese scientists discovered the molecular markers determining the pathogenicity of H5N1 virus, and revealed how the H1N1 virus, widespread in 2009, combined with and H5N1 virus would produce a variety of mutated viruses that are highly communicable and lethal to mammals, with a substantive potential of causing large-scale human influenza. Scientists also revealed the source of the H7N9 virus infecting human, and discovered that the H7N9 virus less pathogenic to poultry could get mutated in human bodies with increased pathogenicity and activity that lead to air-borne human-to-human transmission.

Identification of geminivirus species, research on their molecular mutation and pathogenesis

Chinese scientists identified 30 geminivirus species, analyzed the genetic structure of geminivirus in the plant and the laws of geminivirus mutation and evolution, and explained the pathogenesis of geminivirus and its accompanied satellite DNA. The research was applied in the prediction and forecast of geminivirus and anti-viral breeding, and provided scientific basis for safe and effective strategies to prevent and control the outbreak of geminivirus.

A planting pattern that boosts yield and cuts environmental costs

Chinese researchers proposed and validated a planting pattern that can boost crop yields and reduce environmental costs. With the adoption of an integrated soil-crop system management, researchers significantly boosted the yield of rice, wheat and maize without increasing the use of nitrogenous fertilizers.

(Source: Science and Technology Daily, May 30, 2016)

II. National Food Security

Food security is the top priority of any country to sustain people's livelihood, economic development, social stability and national independence. In the 12th Five Years, China adopted a number of innovative technologies in such initiatives as the "Project on Science and Technology for the Seed Industry", "Project on Bumper Harvest", and "Demonstration of the Bohai Sea Area as a Bread-basket". These projects targeted at major technological barriers in the food production industry, boosted regional food production and substantially strengthened the role of science and technology in national food security. China has always put homegrown innovation of the seed industry high on the agenda of food security, and made technological breakthroughs in hybrid, molecular and new variety breeding. Such achievements have made great contribution to China's seed industry and food security.

Technological innovations in bilinear hybrid rice and large-scale application

Researchers made a significant breakthrough in the fourth phase study of super rice, with a record yield

of 1,026.7 kilograms per mu (666.67 square meters) of farmland. China's total plantation of bilinear hybrid rice added up to 700 million mu, generating additional economic benefits of nearly RMB 40 billion. Such an achievement has reinforced China's food security.

Technology for the breeding of late-stage functional super hybrid rice and its application

Researchers developed a technology for the breeding of late-stage functional super hybrid rice with an aim to boost the rice's photosynthetic capacity in the late stage. Seven rice varieties were developed based on the technology and some of them were certified as national super rice. These new varieties have been introduced to southern provinces with a combined plantation of 33.58 million mu with a total economic return of RMB 1.41 billion.

High-yield, density-tolerant and lodging-resistant maize variety "Zhongdan 909"

A new maize variety named "Zhongdan 909" is characterized by steady high yields, tolerant to high density, eurytopicity, fruitfulness, high seed rate, quality seeds, and strong disease resistance. The average yield is 600-800 kilograms per mu, sometimes exceeding 1,000 kg in trial plantations in the northwestern region and the Huang-Huai-Hai Plain (a large alluvial plain of northern China, built up along the shore of the Yellow Sea by deposits of the Huang He (Yellow River), the Huai River and the Hai River, and a few other minor rivers of northern China).

Wheat variety of "Zhengmai 366"

"Zhengmai 366" is characterized by high protein content and makes doughs of good expansibility and quality flour. The variety has been recommended by food processing companies as the first choice of homebred wheat, and is one of best varieties recommended by the Ministry of Agriculture. The total plantation of the "Zhengmai 366" has exceeded 100 million mu, more than any other strong-gluten wheat variety planted in the country over recent years. The new variety was awarded the Second Prize of State Scientific and Technological Progress in 2014.

Breeding and promotion of common maize variety named "Jingke 968"

Innovative breeding technologies were adopted to develop common maize varieties which have merits like high yields, good quality, strong resistance, eurytopicity and ease of planting. The "Jingke 968" was recommended by the Ministry of Agriculture from 2012 to 2015 as the first choice of maize variety. Its plantation in these years totaled 35.1 million mu, increasing yield by 2.457 billion kilograms and additional output value of RMB 491.4 billion. At present, "Jingke 968" is one of the most-grown maize varieties in China.

Selective breeding and application of new soybean variety "Zhonghuang 13"

"Zhonghuang 13" is a new soybean variety of eurytopicity, high yields, good quality, strong resistance and sound commercial value. Its protein content is as high as 45.8%. Thanks to innovative promotion, the new variety has been widely planted across China as the most-grown soybean variety for eight consecutive years with a combined plantation of more than 80 million mu since 2007.

Creation and application of maize germplasms "Yuzong 5" and "Huangjinqun"

Based on distinctive maize germplasms developed by China, researchers adopted new technologies and new growth models to breed a batch of new maize varieties and plant them in three major maize producing regions. The innovative maize germplasm and varieties made substantial contribution to China's food supply.

"Zhang Zagu" hybrid setaria italica

Chinese researchers successfully bred 10 new varieties of "Zhang Zagu" hybrid setaria italica which are sensitive to light and temperature, and set a world record of the highest yield of 8,119 kilograms per mu. Total plantation areas have exceeded 14 million mu. The varieties have been successfully planted in African countries like Ethiopia, indicating the growing sophistication of China's

technology.

"Zhongshu 18"

"Zhongshu 18" is a high-quality mid/late-season potato variety, featuring steady high yields, extensive adaptability, robust growth momentum, large and regular shapes, strong resistance to disease and slow degradation. The variety is suitable to be planted in northern provinces like Hebei, Shaanxi, Shanxi, Inner Mongolia, as well as southern and southwestern provinces like Yunnan and Guangdong.

Technological support to the upgrade of the potato industry

During the 12th Five Years, China worked out eight national standards regarding the production of potato seeds and commercial potatoes to standardize the entire process from plantation, harvest, storage, to transportation and grading. These national standards are generally used as practical production guidelines.

(Source: Science and Technology Daily, May 31, 2016)

III. Upgrading of Food Industry

Since the beginning of the 12th Five-year Plan, China has conducted research into core technologies about food processing and equipment manufacturing to resolve major technological challenges hampering the development of the food industry and advance the industry's transition and upgrading. Thanks to persistent endeavors, scientists have bred a series of high-yield, good-quality new varieties, developing efficient, healthy and clean cultivation and breeding technologies and providing robust technological support to ensure stable supply of vegetables, fruits, meats, eggs and dairy products all around the year. China is now the world's largest producer of vegetables, fruits, meats, aquatic products as well as poultry and eggs.

Production of premium milk by nutrition regulation on dairy cattle, standardized feeding technology and application

In response to insufficient supply of premium dairy products, scientists uncovered the internal mechanism about the low content of butterfat and lactoprotein in dairy products, and developed core technologies to optimize roughage portfolio and improve the utilization of protein feeds. These technologies increase the content of butterfat and lactoprotein to 3.5% and 3.1%, respectively. Researchers developed a technology that can regulate CLA content in the raw milk and put the technology into practical production. China formulated 11 standards to monitor whole-process dairy production, such as Good Agricultural Practices - Dairy Cattle Control Points and Standards. These standards served as important technological guidelines to standardize cattle breeding.

Breeding and application of "Nongda 3" small layer chicken

Compared to other high-yield layers, the "Nongda 3" small layers are characterized by high feed conversion rate and higher breeding density that reduces feed consumption and the size of hen house. The hens have been widely raised at different regions across China, for they have merits like good quality of eggs, strong disease resistance and high survival rate.

Breeding and raising of new varieties of Beijing duck

Researchers developed new technologies to breed Beijing duck on the basis of quantitative genetics and molecular biology, and successfully bred two new excellent varieties. The varieties can grow to 3.5 kilograms 39 days after birth and improve feed efficiency by at least 35%, resolving the problems brought by the traditional breeding methods, such as slow growth and low feed conversion rate. Introduction of the new varieties has boosted labor efficiency, developed a cooperative model of breeding between research institutes and poultry companies, and generated substantial social and economic benefits.

Selective breeding and industrialization of excellent carp species

The combined use of multi-character breeding and molecular breeding technologies has produced four outstanding carp species with quick growth, fine quality and strong resistance to adverse conditions. The new species resolved problems such as a lack of excellent carp species, diversity and degeneration of genetic characterization, low production and high fatality rate in the winter season. Scientists mapped out the whole-genome sequence of carp.

Flavor and quality control of dry-cured meat products

Researchers developed a production line for automatic sausage production, and a set of equipment to control temperature and the fermentation process, and developed new technologies to control sausage flavor and paint anti-dioxide coatings, and rolled out high-end ham and bacon products. The new technologies and equipment have substantially reduced salt content in the meat products, shortened the production period, and controlled the content of lipid oxide and nitrosamine, improving product flavor, quality and safety.

Suitability evaluation and selection of special varieties in peanut processing

Scientists built a relevance model to measure the relationship between the quality of peanut materials and the quality of finished products, and figured out methods and standards to evaluate the processing suitability. Researchers selected peanut varieties according to different purposes (produce cooking oil, protein or peanut butter), and food enterprises use these dedicated peanut varieties to improve product quality and reduce production cost.

Storage and transportation of waxberry and loquat

Waxberry and loquat are distinctive fruits in China. But losses are as much as 25% to 50% because of tough conditions in storage and transportation. Scientists confirmed that firmness in red loquat is a result of tissue lignification, and developed core technologies to preserve the fruit in a safe and green environment where the humidity and temperature can be remotely controlled. With the adoption of new technologies and standards for storing and transporting waxberry and loquat, the commercial fruit rate increases by 30% to 80%, and average profit increases RMB 3,500-5,000 per ton. Large-scale application of the new technologies has generated indirect economic benefit of RMB 2.44 billion and provided effective support to the development of the fruit industry.

(Source: Science and Technology Daily, May 31, 2016)

IV. Modern Agricultural Industry

In the past five years, China has strengthened the substantive and technological basis of the modern agricultural industry and made remarkable breakthroughs in agricultural IT, intelligent agricultural equipment and modern marine agriculture, with a view to boosting land output, resource utilization rate and labor productivity. These agricultural achievements have produced enormous economic and social benefits, enhanced China's comprehensive agricultural strength and agricultural modernization, and provided technological support to facilitate the information-based, large-scale, intelligent and intensive development of the agricultural industry.

Significant breakthroughs have been obtained in practical technologies and innovative products like agricultural IT and intelligent agricultural machinery. More than 90% of agricultural machines used in the farmland are supplied by domestic manufacturers. Integrated application of a number of advanced technologies has effectively improved the level of intelligent agricultural production in China.

National remote sensing and monitoring of agricultural information

China established its first crop remote sensing and

monitoring system and first high-precision, large-scale and short-cycle disaster remote sensing and monitoring system, providing useful information for government decisions on agricultural production, disaster prevention and reduction.

Quick sensing of plant-environment conditions and real-time monitoring of Internet of Things

In response to three prominent challenges of quick sensing of farmland conditions, steady data transmission and accurate fertilizer & water control, scientists made significant breakthroughs in quick sensing of information about plant nutrition and agricultural disaster & disease, swift testing of soil, water, salt and nutrient conditions, wireless data transmission under complicated farmland conditions, environmental regulation of the Internet of Things, as well as precise management of water and fertilizer supply. These core technologies have been promoted in more than 20 provinces and cities and brought enormous economic and social benefits, and were awarded the second prize of National Scientific and Technological Progress Award.

400hp CVT heavy-duty tractor

Researchers overcame key technological barriers for the CVT system, intelligent control management system and developed China's first 400hp CVT heavy-duty tractor. The tractor features variable load, accurate control of creeping and running speed, and constant PTO output speed, and can be used for heavy-duty farmland operations like deep plowing, subsoiling and land preparations. The launch of the new tractor marks a remarkable technological progress in China's agricultural machinery industry.

Peanut combine

New-type peanut combine was developed and manufactured. The machine can also be used to harvest garlic and has become a popular machine in China to harvest peanut.

New-type intelligent grain combine

China independently developed an intelligent, large-scale grain combine, which features a threshing and separating unit, high-efficiency cleaning, hydraulic-driven chassis and online monitoring of farming operation. The machine was reported as one of the top 10 news in China's agricultural machinery industry in 2013, and honored with the innovation award at the China International Agricultural Machinery Exhibition 2014.

Construction technology of ocean ranching ecosystem

With total intertidal zones and maritime areas accounting for 10% of China's territorial area, we produce more than 30 million tons of maritime products every year and 25% of healthy and high-quality proteins Chinese people need, and generate annual output value of RMB 1.3 trillion, accounting for 26% of China's marine economy and about 10% of the agricultural industry's output value. Based on the principles of marine ecology, researchers integrated technologies for ecosystem restoration, resource preservation, environment monitoring, safety control and comprehensive management, and developed artificial fishing banks to make the best use and management of fishery resources so as to protect the marine environment and ensure safe, efficient and sustainable use of biological resources in the sea, and provide important technological support for the building of a sound ocean ranching.

(Source: Science and Technology Daily, May 31, 2016)

V. Agricultural Development Model

Given the dual restrictions on resources and ecological environment, China's 12th five-year plan on agricultural science and technology put greater emphasis on the pursuit of green development by enhancing the efficiency of resource utilization, improving management of the ecological system and advancing the building of beautiful and livable countryside, and these efforts have laid a solid foundation for sustainable development of the agricultural sector and the rural society.

Feed enzyme technology system innovation and product innovation

In response to poor performance and high production cost of feed enzyme, researchers established a full set of basic research and product development systems, broke up international corporations' technology monopoly and strengthened Chinese products' competitiveness on the international market, bringing substantial economic, social and ecological benefits.

Green gas demonstration project in Yanqing

Biogas is produced through a set of processes from pre-treatment of mixed materials like straws and livestock & poultry excrement, anaerobic fermentation to gas purification. After these processes, the purified biogas contains at least 95% of methane. The clean energy is then transported and supplied to residents in the countryside through CNG vehicles. A project could produce enough clean energy to be consumed by about 10,000 families in the countryside.

Rapid pyrolysis of biomass to make bio-oil

A pyrolysis demonstration project that can produce 10,000 tons of bio-oil a year has been built and put into operation. A formula of composite additives was developed (60-70 units of ethanol, 5-15 units of methyl acetate and 20-30 units of acetonitrile) to improve the stability of bio-oil, and provided an effective option to turn biomass into useful energy resources.

Industrialization of making liquid fuel from straws and demonstration projects with annual capacity of 10,000 tons

In response to the demand for the aviation industry to reduce carbon emissions, scientists developed a technology that can catalyze biomass like straws in the aqueous phase to make jet fuel, and built the world's first 100-ton pilot demonstration system to make biological jet fuel. The fuel was tested by a national oil testing center and met the ASTM international standards for jet fuel. A large-scale development model was built to decompose biomass into intermediate products and get them hydrogenated to make jet fuel, and that has become an important technological solution to meet the target of carbon reduction in the aviation industry.

Accurate sprinkling & irrigation technology and products

Researchers developed low-pressure, multi-function sprinklers that can reduce energy consumption and achieve accurate irrigation, as well as advanced and automatic irrigation systems. These systems have been introduced to Inner Mongolia and Jiangsu and applied to irrigate more than 220,000 mu of farmlands.

Accounting of the value of China's forest resources

Scientists established a set of theoretical frameworks and basic approaches to estimate the value of China's forest resources, providing important basis for improving the national economic accounting system and preparing a balance sheet of natural resources. The accounting work is of great significance to guide scientific and rational use of forest resources, develop modern forestry industry, build ecological civilization and facilitate sustainable economic and social development.

Rapid restoration and reconstruction of mangrove forest

China figured out core technologies to rapidly restore and reconstruct mangrove forest and a set of evaluation index systems, providing solid theoretic foundation and technological basis for building shelter forest along the coastal lines.

Theory and model of low-coverage wind-breaking and sand-fixation

China opened research into how to fixate drift sands in a low-coverage environment (15%-25%). The research has basically addressed the challenge that sand-fixation forests are dying out in the early and middle stage, and explained the impact on forest stability brought by ecological water supply and plant coverage in the desert regions. The research expedited restoration of the artificial forest and advanced the technology of desertification treatment in China.

Research and demonstration of water conservation forest system in Northeast, North and Northwest of China

A typical demonstration project of water conservation forest was developed as a model for similar projects to be built in the Northeast, North and Northwest of China. The project has fully played its role in conserving water and soil, preventing flooding and reducing disasters, and advanced the development of water conservation forests in China.

Preservation & development plan of Tangdong Village, Jinjing Town, Jinjiang City, Fujian Province

With the goal of building a new platform of cultural exchange under the strategy of Maritime Silk Road, Tangdong Village is a well-known hometown of Chinese people living abroad and characterized by distinctive red-brick architectures. The preservation plan underscores the bottom line - protect the village as much as possible during its development, build it into a bridge of cultural exchange and improve the life of local residents.

(Source: Science and Technology Daily, May 31, 2016)

VI. Grassroots Science & Technology Service System

During the past five years, the Ministry of Science and Technology has strengthened resource integration and expedited the concentration of talents, capital and scientific and technological resources in the rural regions. The Ministry has sent TTFs to help farmers establish agricultural businesses, and stepped up efforts to develop a sound science & technology service system in the countryside.

Make a stronger presence of TTF

TTF is a practical innovation based on actual demands from the rural population, and it's an important achievement from the science & technology system reform and the agricultural reform and development. The program was initially launched on a pilot basis in 2002 and expanded across the country in 2009. Now the program has covered roughly 90% of China's territorial areas and made positive contributions towards resolving the issues of agriculture, farmer and rural area and to the push of balanced development in the rural and urban regions. Since 2012 TTF has been included as part of the central government's No.1 document for five consecutive years, highly praised by the United Nations Development Program and recommended to other developing countries. At present, there are 729,000 TTFs working in the frontline, five times the number in 2010, and 38,700 TTFs of legal person status.

National agricultural science parks boost development of modern agricultural industry

During the Five-year Plan period, the Ministry of Science and Technology joined hands with the Ministry of Agriculture, the Ministry of Water Resources, the Forestry Bureau, the Chinese Academy of Sciences, and the Agricultural Bank of China to support the construction of national agricultural science parks, and the work has produced remarkable results. As of 2014, the national agricultural science parks have combined core technology areas of three million mu, demonstration areas of 50 million mu, and radiation areas of 200 million mu. The ministry planned some 20 parks in the major food producing regions and built a number of

demonstration bases to cultivate new crop varieties. These bases introduced and cultivated a total of 40,900 new varieties and brought 14,600 to other places, and crop yields increased at the bases and neighboring regions as a result. The national science parks have expedited the development of 6,376 food enterprises, including 2,642 national and provincial backbone enterprises. These enterprises have a total output value of RMB 482.7 billion and pay RMB 9.55 billion in taxes, paving the way to advance agricultural industrialization and structural transformation. A batch of platforms facilitating cooperation among enterprises, universities and research institutes have been built. 17,000 new agricultural technologies have been introduced and promoted, and more than 70% of scientific accomplishments have been commercialized.

Research Institutes for new countryside development becomes vital force to provide agricultural technology services

With the setting up of 39 research institutes for new rural development at universities, a comprehensive system of agricultural technology services is taking shape to facilitate the development of such services. Over 1,400 full-time professionals are dedicated to grassroots agricultural technology services at 414 bases around the country, covering a total farmland of 44,753 mu planted with crops, economical trees & fruits and vegetables, and they explored different forms of agricultural technology services. Innovation and entrepreneurship education programs were rolled out. 415 new agricultural enterprises were cultivated, 147 innovative businesses were incubated, and 52,500 students and agricultural technicians received opportunities for internships, scientific research and social practices. Various models of farmer training were developed. A total of 617,200 farmers and 77,220 grassroots agricultural technicians received training courses, forming a team of skilled and professional farmers.

Aiding the poor with technology drives development of poverty-stricken regions

The idea of aiding the poor with technology was first put forward in 1986 by the National Science and Technology Commission. The three-decade campaign has proven successful and fruitful from five perspectives. First, we fostered a notion that poor people should rely on science, technology and innovation to get rich, instead of asking for government subsidies and assistance. Second, we accelerated the application and promotion of advanced technologies to help farmers in the impoverished regions develop characteristic agricultural businesses and increase income. Third, we advanced the establishment of science & technology service system in the rural regions and brought such services to the doors of poor people. Fourth, we strengthened team-building efforts to increase poor people's science awareness and improve their self-development abilities. Fifth, we built science parks in the poverty-stricken regions and provided a solid basis for the regions to implement the innovation-driven development strategy.

(Source: Science and Technology Daily,
May 31, 2016)