CHINA SCIENCE AND TECHNOLOGY NEWSLETTER

Department of International Cooperation
Ministry of Science and Technology(MOST), P.R.China

No.20-21
November 10 2013

Special Issue: China's National S&T Programs

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China's national scientific and technological (S&T) programs include National S&T Major Projects, National Basic Research Program, National Hi-tech Research and Development (R&D) Program, National Key Technologies R&D Program, International S&T Cooperation Program, Policy Guidance Programs, National S&T Innovation Base Program and other programs. Moreover, in 1980-1990s, the State Council approved the establishment of National Natural Science Foundation of China (NSFC) and Innovation Fund for Technology-based Firms, giving strong support to basic research and the development of SMEs.

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The national S&T programs, administrated by the Ministry of Science and Technology (MOST), fund projects selected through peer review, while NSFC is an independent foundation offering funds for basic research in natural science.

The national S&T programs set overall deployment for strategic R&D and S&T activities in the following nine aspects: 1) Major strategic projects and key and common technologies that are closely associated with national development goals; 2) Strategic basic research for the demand of national development and basic research based on free thinking of scientists; 3) R&D, integrated application and industrialized demonstration of frontier technologies; 4) R&D and demonstration of industrial generic technologies that provide solutions to major S&T problems in the course of economic development as well as technologies for public welfare; 5) International S&T cooperation and exchanges involving enterprises, universities and research institutes under bilateral and multilateral inter-governmental cooperation framework; 6) Major S&T innovation bases; 7) Projects concerning agriculture, industry, commercialization of research findings and development of research infrastructure in accordance with national S&T policies; 8) Innovative Personnel Cultivation Project; 9) Two National funds: National Natural Science Foundation of China and Innovation Fund for Technology-based Firms.

1. National S&T Major Projects

The Outline of National Medium- and Long-term Program for Science and Technology Development (2006-2020) (MLP) states that in the priority topics defined in key areas, focuses are further narrowed and a number of specific R&D projects involving strategically important products, key and common technologies and important engineering projects are selected in line with national goals. These projects are designed to make breakthroughs in key areas, by taking full advantage of the socialist system in pooling resources for big undertakings and the role of the market economy, in a bid to achieve quantum leaps in productivity.

The selected projects fall into the following categories:

1) strategic industries that are closely linked to the major needs of the nation's economic and social development, capable of coming up with core proprietary intellectual property rights, and substantially boosting innovativeness of enterprises; 2) key and common technologies that can drive the improvement of the overall industrial competitiveness; 3) projects that are aimed at overcoming major bottlenecks constraining economic and social development; 4) activities that combine civilian and defence purposes and are of strategic importance to national security and improvement of comprehensive national strength; 5) efforts that conform with the nation's circumstances and fall within the limits of its resources.

Based on these principles, a number of major R&D projects have been selected to promote high-

tech industry development and traditional industry upgrading, resolve bottlenecks on economic development, improve public health, and safeguard national security. These projects will be launched upon further review and approval on a case-by-case basis, in light of the nation's needs and the readiness for implementation. Meanwhile, these projects will be adjusted dynamically along with the nation's evolving strategic needs and circumstances, and will be implemented in a well-paced manner. For the projects aiming to develop strategic products, enterprises are expected to be the principal player in the R&D and investment. Major equipment is what to start with in enterprises' technological innovation, and a more market-based approach will be adopted in allocating S&T resources. Meanwhile, the investment by the government, which acts as a catalyst for more input from businesses, will be mainly used to develop key technologies.

Major R&D projects are designed to develop strategic products or key technologies, or complete important engineering projects within a timeframe by making technological breakthroughs and pooling resources, in a bid to meet the nation's goals. For this reason, they hold the key to the nation's development of science and technology. 16 such projects have been identified in the MLP, including core electronic devices, high-end generic chips and basic software, super large-scale integrated circuit manufacturing and associated techniques, next-generation broadband mobile telecommunication, high-grade CNC machine tools and basic manufacturing technology, large oil-gas field and coal-bed methane development, large advanced pressurized water reactors and high-temperature gas-coolant reactor nuclear power stations, water pollution control and treatment, new genetically modified varieties, major new drugs, prevention and treatment of major infectious diseases such as HIV/ADIS and viral hepatitis, large passenger aircrafts, high-resolution earth observation systems, manned space flights, and the moon probe. They cover a range of strategic sectors including information and biotechnology, pressing issues concerning energy, resources, environment and public health.

2. National Basic Research Program of China (973 Program)

On June 4th 1997, the third meeting of the former National Science and Technology Steering Group decided to formulate and implement the National Basic Research Development Plan, and later, the National Basic Research Program of China (973 Program) was implemented by MOST. The purpose of the Program is to strengthen original innovation, resolve major scientific problems concerning socio-economic development, enhance China's capacity in innovation and in resolving major problems and provide scientific support to boost future development.

The major missions:

1) launch cross-disciplinary research and provide

theoretical proof and scientific bases for resolving socio-economic problems concerning agriculture, energy, information, resource, environment, population, health and material; 2) carry out relevant, critical and explorative basic research; 3) cultivate personnel with good scientific knowledge and innovation capacity; 4) establish high-level scientific research bases that undertake major scientific tasks and build cross-disciplinary research centers.

The projects in the 973 Program are those require national efforts for implementation and can comprehensively promote national development and S&T progress. The projects are selected through peer review in line with principles of honoring need, priority, excellence, openness, fairness and justice. Generally, each research project is run within a time limit of five years.

The 973 Program is led by MOST, together with NSFC and other relevant departments. Each project is managed by a panel of experts under the leadership of the chief scientists. The chief scientists are responsible for the overall implementation of the projects, while daily management goes to relevant institutions that guarantee the implementation.

During the 11th Five-Year Plan period, the 973 Program has pooled a group of excellent scientists home and abroad, who carried out strategic basic research and focused on integrating research with potential demand of industrial utilization. As a result, a number of research findings had been generated and played an increasingly important role in national economy and society, and a number of innovative achievements were highly influential in the international academic community. During the same period, 497 projects were launched within the Program with the engagement of about 250,900 researchers, more than 160,000 papers were published, among which about 100, 000 were cited in SCI or EI papers. More than 5,600 patents for invention were licensed, 224 national prizes awarded and 69,000 graduate students cultivated.

3. National Hi-tech R&D Program (863 Program)

In March 1986, to meet the global challenges of new technology revolution and competition, four Chinese scientists, Wang Daheng, Wang Ganchang, Yang Jiachi and Chen Fangyun, jointly made the proposal of "following up with strategic hi-tech development of foreign countries", which was approved by the late Chinese leader Deng Xiaoping. In November 1986, the State Council decided to initiate the Hi-tech R&D Program, namely the 863 Program.

Over the past twenty years, the 863 Program has always been following the latest hi-tech development in the world. In order to enhance China's innovation capacity, the Program focuses on major hi-tech areas concerning the nation's long-term development and national security, takes strategic, forward-looking and frontier technology R&D as its priority, coordinates R&D, integrated application and industrialized demonstration and gives full play to hi-tech in guiding

future development.

As a result, the 863 Program has laid a solid foundation for hi-tech development and industrialization in the country. During the 11th Five-Year Plan period, a total fund of 63.72 billion yuan were allocated within the Program, 37.8% of which from the central finance; 421,000 researchers participated in the specific projects; 145,000 papers were published, among which over 40,000 were included in EI, SCI and ISPT; 99,200 graduate students were produced; 37,000 applications for invention patents were filed, among which about 9,000 were granted with license; more than 3,200 technical standards were made; over 200 national S&T prizes were awarded. The 863 Program has generated a number of innovative achievements reaching or approaching world advanced level, especially in areas of high-performance computer, 3G mobile communication, high-speed information network, deep-sea robot and industrial robot, earth observation system, ocean observation and exploration system, new-generation nuclear reactor, super hybrid rice, pest-resistant cotton and genetic engineering.

Great emphasis was given to hi-tech integrated innovation and strategic emerging industries. Chinese research teams have developed a series of advanced scientific achievements in hi-tech areas like bio-engineering medicine, communication equipment, high-performance computer, Chinese information processing platform, intraocular lens and optoelectronic material and devices. All these have formed new growth points for the hi-tech industry, providing strong scientific and technological support to national defense as well.

At present, the 863 Program has become a flagship program in China's S&T development, especially in hi-tech R&D. Its achievements are playing a vital role in enhancing innovation capacity, improving the nation's comprehensive strengths and boosting national confidence.

4.National Key Technologies R&D Program

National Key Technologies R&D Program is a special S&T Program aiming at resolving major S&T problems in the course of economic and social development. To fulfill objectives in key areas set out in the MLP, the Program takes R&D, application and demonstration of major technologies for social welfare and industrial generic technology as the priority, integrates construction of major engineering projects and equipment development, and strengthens integrated innovation and the improved technology–based development. Targeted at cross-sector and cross-region major technological problems, the Program contributes to balanced economic and social development by making breakthrough in key technologies, removing bottlenecks and strengthening industrial competitiveness. Meanwhile, The Program is dedicated to cultivating high-level innovative personnel and teams, establishing world-class technology innovation bases, accelerating economic restructuring and growth-mode transformation, improving people's livelihoods and providing strong

S&T support.

The National Key Technologies R&D Program mainly supports R&D, application and demonstration in areas like energy, resources, environment, agriculture, material, manufacturing, transportation, information industry and modern service industry, population and health, urbanization and urban development as well as public security.

During the 11th Five-Year Plan period, 80.343 billion yuan were invested in National Key Technologies R&D Program, among which central financial allocation stood at 23.377 billion yuan, accounting for about 29.1%. The Program emphasizes support to innovative personnel and takes personnel cultivation as an important benchmark. There were about 570,000 research staff involved in the Program during this period. The Program reflects both strategic goals at the national and regional level and the S&T plans and socio-economic issues at the local level. About 21% of the projects within the Program were related to technologies and equipment development for national major engineering projects, like Three Gorges Dam, Qinghai-Tibet Railway, Beijing-Shanghai High-speed Railway, Gas Transmission from West China to East China, South-to-North Water Diversion, Beijing Olympic Games and Shanghai World Expo. During these five years, over 120,000 papers were published, among which over 20,000 were published in international journals. There were almost 30,000 patent applications, among which patents for inventions reached 20,000 and about 6,000 patents were licensed, 11,000 technical standards were made and 283 national S&T prizes were awarded.

5. International S&T Cooperation Program of China

The international S&T Cooperation Program was established in 2001 by MOST and is implemented jointly by a range of departments and institutions. By coordinating and integrating China's S&T resources in enterprises, universities and research institutes, the Program aims to launch wide-ranging and in-depth international S&T cooperation and exchanges, effectively utilize the world's S&T resources and enhance S&T innovation capacity, thus jointly facilitating S&T progress of mankind.

The Program is an effective way to facilitate S&T cooperation featuring mutual benefit and win-win outcomes in an open environment and resolve common S&T problems in energy, resource, environment and health. It is an important platform for promoting bilateral and multilateral S&T cooperation and serving modernization and diplomacy policies. It is also a key measure for improving coordination across departments and regions and enhancing innovation capacity through the national innovation system.

The Program supports:

1) Inter-governmental S&T cooperation projects boosting S&T progress, economic and social development and diplomacy confirmed by bilateral and multilateral S&T cooperation agreements or frameworks;

2) High-level international S&T cooperation projects dedicated to addressing pressing needs and resolving major S&T and key technology problems impeding economic and S&T development in line with national policies for S&T cooperation and on the basis of the need of national security;

3) Practical joint R&D with foreign first-rate research institutes, universities and enterprises as well as projects that attract excellent foreign scientific personnel or teams for short-term or long-term cooperation, and that help build international S&T cooperation bases and enhance indigenous innovation capacity.

In accordance with the principle of bringing in and going global as well as the international norms of reciprocity, mutual benefit and reasonable sharing, the Program deals with various challenges and opportunities brought by globalization, makes the country more open, carries out wide-ranging and high-level S&T cooperation and exchanges, realizing substantial progress in international S&T cooperation and national S&T development goals. At present, a cooperation framework featuring government guidance, civil participation, institutional interaction and synergy among enterprises, universities and research institutes has been established, and an all-dimensional, multi-tier and wide-ranging international cooperation pattern has taken shape.

The Program has established a number of databanks of experts, projects, achievements and management information and built a network of over 10,000 experts in 500 majors and 40 disciplines, which has provided strong technical support to the operation and management of the Program.

6. National S&T Innovation Base Program

Through building state key laboratories, national engineering research centers and national S&T infrastructure platforms, the National S&T Innovation Base Program facilitates the building of important scientific research infrastructure, promotes R&D of engineering technology, supports industrial innovation and realizes the sharing of scientific research infrastructure and information resources.

In 1980s, relevant departments utilized a World Bank loan of over 86 million dollars and 170 million yuan in building 75 state key laboratories, which supported R&D in applied basic research and engineering technology as well as formed a nationwide network of major scientific research infrastructure. Thanks to continued support from national authorities, 393 laboratories have been designated as national key laboratories by the end of 2012.

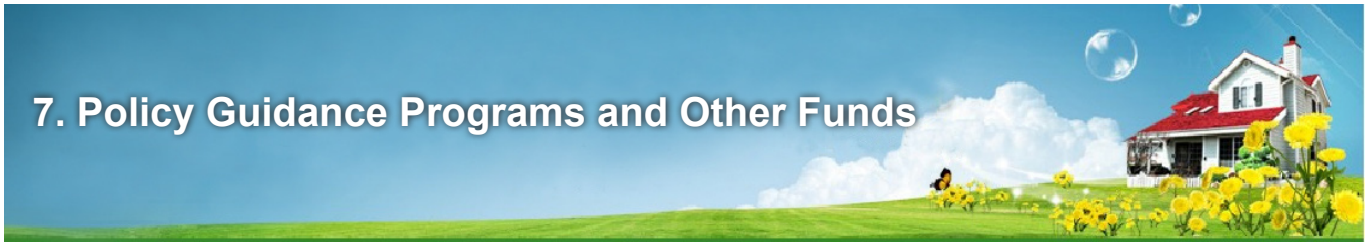
In order to implement the MLP, strengthen the building of state key laboratories and enhance innovation capacity, the central government set up a special fund in 2007, to offer stronger support to state key laboratories in open management, research freedom and upgrading of scientific devices. In 2012, 3.178 billion yuan were invested for building state key labs in 260 universities, and 200 million yuan were allocated to build 6 pilot

national labs.

National engineering technology research center (hereinafter referred to as Engineering Center) is a R&D platform of technology based on research institutes, universities or enterprises with strong S&T strengths. Built with professional teams in R&D, design and testing of engineering technology as well as equipped with comprehensive supportive testing devices, the Engineering Center provides industrial public services and forms a development mechanism featuring virtuous circle.

The Engineering Center is an important component of national major innovation base and national innovation system, aiming to strengthen central links of translating research findings into productivity, make research findings more mature and applicable and offer support to economic and social development. By the end of 2012, 327 national engineering centers have been built nationwide, covering wide-ranging areas such as agriculture, electronics and information communication, manufacturing, material, energy conservation and new energy, modern transportation, biology and medicine, resource development, environmental protection, ocean development and social causes.

The national S&T infrastructure platforms aims to build cross-area and high-level national basic research and experiment bases, better equipment in priority areas and foster an open and sharing research and experiment environment. The national S&T infrastructure platforms have gradually evolved into a nationwide network, facilitating the sharing of large-scale scientific devices and infrastructure, improving the comprehensive efficiency for utilization of research infrastructure, as well as forming a number of comprehensive and professional field observation and experiment bases featuring integrated operation and resource sharing. During the 11th Five-Year Plan period, 5 S&T infrastructure platforms have been built to meet the need of research and experiment bases with large scientific devices.



7. Policy Guidance Programs and Other Funds

Policy guidance Programs are special action plans reflecting national S&T policy intentions at different stages, being proposed from the mid-1980s by MOST. For example, the Spark Program initiated in 1986 accelerates the development of enterprises in towns and counties and that of emerging industries by promoting utilization of appropriate technology in rural China, facilitating adjustment of agricultural structure and comprehensively improving productivity.

The Torch Program launched in 1988 facilitates the development of High and New Technology Industrial Development Zones (Hi-tech Zones) by supporting local industries in developing hi-tech sector. At present, 105 national hi-tech zones have been built, becoming industrial clusters with the highest technological standard and efficiency, the most extensive international

connections and the greatest contribution to regional economic growth.

Later, MOST and relevant departments jointly proposed the National Major and New Product Plan, which effectively encouraged enterprises to develop new products. In addition, the Soft Science Research Plan provided a scientific research basis for the government to make forward-looking, available and effective S&T policies.

In the 21st century, on the basis of previous policy guidance programs, MOST and the Ministry of Finance jointly proposed and implemented the S&T Program for Public Wellbeing, which aims to strengthen social management innovation by S&T progress and serve people at the grass-root level by demonstrating a series of integrated technologies and promoting use of advanced appropriate technology achievement.

In recent years, a number of special funds have been established, including the National Magnetic Confinement and Nuclear Fusion R&D Fund, the Fund of Enriching People and Counties through science and technology, National Major Scientific Equipment Development Fund, Research Institute Technology R&D Fund and the Agricultural S&T Achievement Translation Fund, etc.

8. Innovative Talents Development Program

On June 6th 2010, the CPC Central Committee and the State Council jointly promulgated the National Medium- and Long-Term Plan for Human Resource Development (2010-2020) (hereinafter referred to as the Plan), which proposed the Strategy of revitalizing the country by developing human resources and made a thorough arrangement of human resource development. The Plan confirmed the strategic goal of revitalizing the country by developing human resources, identified the content of institutional innovation and major policy measures, established twelve major human resource projects, systematically promoted the cultivation of various types of personnel and highlighted the important task of cultivating innovative scientific personnel.

The Innovative Talents Development Program, the primary task of the twelve major human resource projects confirmed by the Plan, was proposed by MOST and jointly implemented in 2012 together with the Ministry of Human Resources and Social Security, Ministry of Finance, Ministry of Education, Chinese Academy of Sciences, Chinese Academy of Engineering, National Natural Science Foundation and China Association for Science and Technology.

Through innovating institutions, improving policy environment and strengthening guarantee measures, the Innovative Talents Development Program aims to produce world-class scientists, high-level scientific pioneers and engineers, excellent innovation teams and entrepreneurial personnel, establish training and demonstration bases of innovative personnel, cultivate high-end innovative scientific personnel, guide the development of various types of personnel,

thus providing support of human resource to enhance indigenous innovation capacity and build an innovative country. The Program also helps realize the general objective of human resource development in China: develop human resource featuring large quantity, optimized structure, reasonable distribution and high quality as well as establish a comparative advantage in human resource competition, thus becoming a strong nation in human resource and laying a solid human resource foundation for realizing socialist modernization by the middle of the century.

The specific tasks of the Program are to set up 100 scientists' offices in research areas with comparative advantages by 2020, to cultivate 3,000 young innovative personnel each year in world S&T frontier and strategic emerging industries, to help 10,000 excellent entrepreneurial personnel utilizing IPR and home-grown technology for their startups and to build 500 innovation teams in priority areas and 300 training and demonstration bases for innovative personnel. At present, with the recommendation of localities and departments and assessment of experts, MOST has confirmed the assessment of two batches of Innovative Talents Development Programs.

(source:MOST,Nov 2013)

9. National Natural Science Foundation of China and Innovation Fund for Technology-based Firms

In mid-1980s and 1990s, in order to implement the reform of S&T management and offer more support to basic research, in line with national economic and industrial development and the principle of promoting SME development, the State Council decided to set up the National Natural Science Foundation to support basic research and the Innovation Fund for Technology-based Firms to accelerate the development of SMEs.

1) National Natural Science Foundation of China

In the early 1980s, the State Council consented the suggestion by 89 academicians of the Chinese Academy of Sciences on the establishment of a national natural science foundation for further promoting the reform of S&T system and S&T fund appropriation in China. The National Natural Science Foundation of China (NSFC) was established under the ratification of the State Council on February 14, 1986.

Since the establishment of NSFC, an advanced science funding system integrating the evaluation and funding mechanisms has been introduced and implemented. The administrative system has been well developed and improved for the decision-making of the funding policy, the implementation of funding programs and the supervision of funding operation. The management system of project implementation and a complete set of regulations have been formulated on the basis of peer review and performance evaluation.

NSFC has gradually established its funding system focusing on research programs, personnel cultivation and infrastructure construction, with the focus on supporting

basic research. NSFC has established multi-tier and integrated funding programs, including key programs, major programs, major research programs, joint funds and practical international joint research. Policies concerning personnel cultivation are implemented through National Fund for Talent Training in Basic Science, Young Scientists Fund, Regional Science Fund, National Science Fund for Distinguished Young Scholars and Fund for Creative Research Groups.

Along with increased investment to basic research by the government, the budget for NSFC has been increased from 80 million yuan in 1986 to 4.33 billion yuan in 2007, which has significantly improved the funding environment for basic research and the funding for specific projects. Over the past twenty years, NSFC has made dramatic achievement in basic discipline building as well as discovery and cultivation of excellent S&T personnel, making great contribution to the overall improvement of basic research in China.

(From: www.nsfc.gov.cn)

2) Innovation Fund for Technology-based Firms

The Innovation Fund for Technology-based Firms (hereinafter referred to as Innovation Fund) is a government special fund for science and technology-based SMEs with the approval of the State Council. Through financial allocation, loaning with discounted interest and capital investment, the Innovation Fund supports and guides the technological innovation of SMEs, facilitate the translation of research findings, build a number of science and technology-based SMEs with Chinese characteristics and accelerate the industrialization of high and new technologies. It plays a significant role in optimizing industrial and product structure, expanding domestic demand, creating employment opportunities and facilitating healthy, stable and rapid development of the national economy.

As a government special fund, the Innovation Fund, which is operated according to the rules of market economy, supports all types of science and technology-based SMEs, welcomes investment from local governments, enterprises, investment institutions and financial institutions and gradually establishes hi-tech industrialized investment mechanism that conforms to market economy rules. All these will further optimize S&T investment resources and build a sound environment for the innovation and development of SMEs.

In 2012, in order to implement the State Council's *Guideline Opinion on Deepening Reform of the Scientific & Technological System and Accelerating Development of a National Innovation System* as well as the Guiding Principles of the 18th National People's Congress, according to the principle of integrating economic development with science and technology, the Innovation Fund effectively utilized the funds, constantly optimized entrepreneurial environment and guided social fund and other funds, in a bid to comprehensively enhance the innovation capacity of science and technology-based SMEs and meet the strategic demand of developing emerging industries.

In 2012, the central finance arranged 4.37 billion yuan as innovation fund, established 7,436 projects with a total volume of 5.134 billion yuan; throughout the whole year, 4,826 projects were assessed, with the approval rate standing at 90.7%. By 2012, the Innovation Fund has accumulatively invested 22.09 billion yuan and set up 39,836 projects.

The Innovation Fund has played a sound demonstration and guiding role in supporting technological innovation of SMEs. According to statistics, in 2012, the Innovation Fund has pushed local governments, banks and other social sectors to invest 51.433 billion yuan, among which local supporting fund stood at 1.348 billion yuan. The Innovation Fund continues to step up its efforts in supporting less

developed regions. In 2012, 721 million yuan were allocated to the West China, an increase of 31.6%, and altogether 1,197 projects were supported.

On the basis of the experience over the past several years, with increased input year by year, the Innovation Fund has played a substantial role in enhancing enterprises' innovation capacity, translating and industrializing research achievements, increasing job opportunities, improving enterprises' economic and social efficiency and facilitating optimization of the industrial pattern. All this has facilitated the rapid growth of science and technology-based SMEs in China.

(source:Torch High Technology Industry Development Center, MOST, www.innofund.gov.cn)

(Editor's Note: All news in the issue are translated from Chinese texts for your reference. They are subject to checks and changes against official release of original Chinese or English texts.)