12 HARNESSING SCIENCE, TECHNOLOGY AND INNOVATION

I. INTRODUCTION

12.01 During the Eighth Plan period, efforts were focused on strengthening science and technology (S&T) capability and capacity to support productivity-driven growth and improve competitiveness. In this regard, various measures were implemented to increase the diffusion and application of technology, promote commercialisation of research and expand S&T human resource. The private sector continued to contribute towards the expansion of research and innovation activities, particularly in high value added industries. Arising from the collective efforts of the public and private sectors, the S&T indicators registered improvements in terms of research intensity and scientific and technological human resource.

12.02 Taking into cognisance the increasingly challenging and competitive global environment, the development thrust for the Ninth Plan period will be to harness science, technology and innovation (STI) as a key driver in raising national capacity to acquire and utilise knowledge and foster innovation. Towards this end, a holistic approach to strengthen the National Innovation System (NIS) will be adopted to enhance productivity and competitiveness. The advancement, dissemination and application of knowledge and technologies will be intensified to add value to the nation's diversified economic activities. Higher priority will be given to market-oriented research and development (R&D) and increasing the rate of commercialisation. Concerted efforts will also be geared towards enhancing human capital to strengthen technological capability and capacity to support innovation-led growth.

II. PROGRESS, 2001-2005

12.03 The S&T policy continued to lay the foundation for the attainment of a scientific and technologically advanced society and support the national development strategy of productivity-driven growth. In this regard, the STI input indicators such as R&D expenditure and number of researchers as well as output indicators in terms of number of patents granted and publications, recorded improvements.

National R&D Expenditure

12.04 During the Plan period, R&D was given due priority as reflected by the increase in national gross expenditure on R&D (GERD) from RM1.7 billion in 2000 to RM4.3 billion in 2005, at an average annual rate of 20.8 per cent[1], as shown in *Table 12-1*. This rate of growth in GERD exceeded the average growth rate of 20.4 per cent per annum required to achieve the GERD to gross domestic product (GDP) ratio of 1.5 per cent by 2010. The ratio of GERD to GDP, a measure of research intensity, increased from 0.5 per cent in 2000 to 0.9 per cent in 2005.

TABLE 12-1

SCIENCE, TECHNOLOGY AND INNOVATION INDICATORS, 2000-2005

Indicator	*2000*	*2002*	*2005*[e]
National Gross Expenditure on R&D (RM million)	1,671.5	2,500.6	4,300
Public	703.6	867.5	1,500
Private	967.9	1,633.1	2,800
National Gross R&D Expenditure (% to GDP)	*0.5*	*0.7*	*0.9*
Number of Researchers	15,022	17,790	27,500
Number of Researchers per 10,000 Labour Force	15.6	18.0	25.0
Proportion of Time Spent on R&D (FTE[1])	*43*	*43*	*55*
Total Patents Filed	6,227	4,937	6,286
Resident	206	322	522
Non-resident	6,021	4,615	5,764
Total Patents Granted	405	1,492	2,508
Resident	24	32	37
Non-resident	381	1,460	2,471
Publication in International Journals	1,930	2,016	2,293
Royalties (RM million)			
Receipts	70.4	74.1	98.0
Payments	2,268.1	2,399.0	5,851.0
Net	-2,197.7	-2,324.9	-5,753.0

Source: Ministry of Science, Technology and Innovation, Bank Negara Malaysia and Department of Statistics

Notes: [e] estimates

[1] Full Time Equivalent (FTE) is based on the actual proportion of time spent on R&D.

[1] The National Survey of Research and Development 2002 and 2004 Reports and projections.

Technology Inflows

12.05 There was a widening deficit in terms of technology, royalties and fees as reflected in the balance of payments. Although foreign technology acquisition represented a means to expedite technological advancement, the increased deficit in royalties and fees underscored the need to step up efforts towards enhancing homegrown technological capabilities.

Public Sector R&D Programme

12.06 In accordance with the priority given to R&D, the funding for R&D grant schemes expanded by 59.9 per cent compared with the Seventh Plan period. With this increase, a total of RM1.4 billion was allocated for R&D during the Eighth Plan period. Of this total, RM1.0 billion was provided for direct public sector involvement in R&D while the remaining RM430 million was allocated to enhance private sector R&D through the Industry Research and Development Grant Scheme (IGS), MSC Research and Development Grant Scheme (MGS) and Demonstrator Applications Grant Scheme (DAGS).

12.07 The Intensification of Research in Priority Areas (IRPA) funding mechanism was fine-tuned to ensure more effective and efficient implementation of research projects. During the Plan period, a total of 2,139 projects valued at RM836.9 million was approved under the IRPA programme, as shown in *Table 12-2*. An assessment of 1,233 IRPA projects implemented during the Plan period indicated, among others, the filing of 544 intellectual property rights (IPRs) such as patents, industrial designs, and copyrights as well as 4,872 publications including national

TABLE 12-2

IRPA PROGRAMME APPROVALS BY AREA OF RESEARCH, 2001-2005

Area	*Projects Approved*		*Amount Approved*	
	Number	*%*	*RM million*	*%*
Science and Engineering	576	26.9	137.1	16.4
Agro-industry	420	19.7	95.8	11.4
Manufacturing and Construction	311	14.5	358.9	42.9
Health	219	10.2	115.4	13.8
Services and IT	204	9.5	47.1	5.6
Social	151	7.1	21.4	2.6
Environmental	119	5.6	21.7	2.6
Energy, Mineral and Geo-Science	74	3.5	32.7	3.9
Economics	65	3.0	6.8	0.8
Total	**2,139**	**100.0**	**836.9**	**100.0**

Source: Ministry of Science, Technology and Innovation

and international papers. These projects also provided opportunities for capacity building and were instrumental in producing 92 Doctor of Philosophy (Ph.D) and 338 Masters graduates as well as enhancing the capabilities of 765 research staff in new and emerging technologies.

12.08 The Biotechnology R&D Grant Scheme established in 2001 under the National Biotechnology Directorate approved a total of RM95.3 million for 47 biotechnology research projects in priority areas such as molecular biology, agro-biotechnology and medical biotechnology. The Scientific Advancement Grant Allocation (SAGA) enabled promising researchers at institutions of higher education to work on basic research for capacity building and knowledge advancement in fundamental sciences. This was part of the overall endeavour towards realising the long-term objective of having Malaysians conferred the Nobel scientific award.

12.09 In an effort to encourage private sector participation in R&D activities, an allocation of RM127.1 million was approved under the IGS. An evaluation of the 65 completed IGS projects indicated that 26 projects or 40 per cent were commercialised with total sales of RM149.6 million while the remaining were in the process of further commercialisation. In addition, 24 IPRs in the form of patents, copyrights and trademarks were filed.

12.10 During the Plan period, MGS continued to provide assistance to innovative local companies to develop multimedia technologies and applications. The gains from the MGS included the commercialisation of 27 projects with total sales of RM198.5 million and listing of 12 MGS companies in the Malaysian Exchange of Securities Dealing and Automated Quotation (MESDAQ). To foster wider application of information and communications technology (ICT) at the community level and spur innovations, an allocation of RM79.3 million was approved for 51 projects under the DAGS. A number of these projects contributed towards bridging the digital divide including the *e-bario* and *e-pekak* projects which demonstrated the usage of ICT by a remote rural community in Sarawak, and improving ICT literacy among the deaf community, respectively.

Commercialisation of Research and Technology

12.11 An evaluation of R&D Projects funded under the IRPA Programme during the Seventh Malaysia Plan, revealed that only 3.4 per cent of the projects were commercialised during the Eighth Plan period. This indicated the need to provide more extensive assistance for downstream development of R&D initiatives. To expedite the rate of commercialisation, a package of programmes was put in place. The Commercialisation of Research and Development Fund (CRDF) facilitated the development of a number of new products and production processes as well as assisted participating companies to start-up production capacity. In addition, the Technology Acquisition Fund (TAF) provided assistance to companies to acquire strategic foreign technologies for further value creation.

12.12 As part of efforts to accelerate commercialisation of R&D findings, new fiscal incentives such as pioneer status for 10 years and tax deductions equivalent to actual investment were made available. To promote commercialisation of R&D in agriculture by the private sector, a fund of RM300 million was established in 2005. The research management and commercialisation unit of universities and research institutions were strengthened to increase the uptake of commercialisation of public sector R&D findings.

Indigenous Capacity Building in Key Technologies

12.13 In line with the Second Science and Technology Policy (STP2) and the Second Industrial Master Plan (IMP2), efforts were intensified to strengthen indigenous capacity and capability in key technology areas. Emphasis was given to capacity reinforcement of key technologies, particularly in biotechnology, ICT, advanced manufacturing, advanced materials, aerospace-related technology and nanotechnology.

12.14 *Biotechnology.* To support the development of the biotechnology industry and enhance synergy among the key stakeholders, three laboratories were established. These laboratories were in the areas of agro-biotechnology at the Malaysian Agricultural Research and Development Institute (MARDI), genomics and molecular biology at the *Universiti Kebangsaan Malaysia* (UKM) as well as pharmaceuticals and nutraceuticals at the *Universiti Putra Malaysia* (UPM). These initiatives were boosted with the launching of the National Biotechnology Policy in April 2005.

12.15 *Information and Communications Technology*. As part of efforts to enhance domestic capabilities in ICT application and development, the R&D focus areas included pervasive computing, cyberspace security as well as semiconductor and microelectronics. In the area of semiconductors and microelectronics, R&D activities included semiconductor processes such as fabrication, test and failure analysis as well as digital and analogue design of integrated circuit (IC), and advanced microelectronics.

12.16 During the Plan period, *advanced manufacturing* technology was given emphasis to enhance competitiveness of the manufacturing sector. The technology services offered included rapid prototyping and systems development through contract research, consultancy and training programmes. Recognising the importance of *advanced materials* to industrial competitiveness, the Advanced Materials Research Centre (AMREC) and several other research institutions and universities conducted R&D on a wide range of advanced materials for industrial applications.

12.17 *Aerospace-related technology* continued to be given due priority to strengthen technological development capability and generate new sources of growth. The National Micro-Satellite Programme and TIUNGSAT-1 provided the

foundation towards developing the capability and potential in the field of aerospace-related technology. In addition, a mission operations facility was set up in 2005 to enable the command and control of national satellites.

12.18 *Nanotechnology*. Recognising the potential impact of nanotechnology on a wide range of industries, efforts were focused on capacity building in nanoscience and nanotechnology research. The areas of nanotechnology R&D undertaken were related to nanoparticles, micro-machining and fabrication as well as sensors for electronics, communications, automotive and chemicals industries.

Innovation and Intellectual Property

12.19 In view of the significant role of patents in promoting innovation and serving as a source of new product development, greater emphasis was placed on the generation of intellectual property (IP). In this regard, the number of patents filed by residents increased from 206 in 2000 to 522 in 2005. The number of patents granted to residents increased from 24 in 2000 to 37 in 2005. Recognising the need to strengthen the patent registration and management system, the Intellectual Property Corporation of Malaysia (MyIPO) was established in 2003.

Strengthening Technological Capability of SMEs

12.20 Various measures were undertaken to strengthen the technological capability of the small and medium enterprises (SMEs). In this regard, a number of technology and research-based agencies provided extension services, including business and technical skills training as well as technical consultations to assist new and existing SMEs. Facilities and funding were also made available to strengthen R&D capability, design capacity and prototyping activities for potential commercialisation products and processes to produce higher value-added products. These activities contributed towards the enhancement of technological capabilities of participating SMEs, especially in the provision of high quality parts and components to a number of industries.

Incubators for New Technology-based Enterprise Creation

12.21 During the Plan period, technology incubation was given emphasis to serve as catalysts for the creation and nurturing of new technology-based enterprises. In this regard, technology incubator programmes were implemented by SIRIM Berhad, Technology Park Malaysia (TPM), Malaysian Technology Development Corporation (MTDC), Multimedia Development Corporation (MDC) and Kulim Hi-Tech Park. Several institutions of higher education such as *Universiti Sains Malaysia* (USM) and *Universiti Teknologi Malaysia* (UTM) also established incubator programmes to commercialise their R&D output. During the Plan period, a total of 400 companies benefited from the services provided such as shared facilities, technical assistance and entrepreneur development.

Standardisation and Quality Assurance

12.22 During the Plan period, greater emphasis was placed on meeting international standards through testing, measurement and quality assurance. A milestone was achieved in standardisation efforts with the implementation of the National Standards Strategy and Action Plan in 2004. The Plan aimed at further improving productivity and competitiveness as well as protecting consumer interests and the environment.

12.23 The Department of Standards Malaysia (DSM) became a signatory to mutual recognition arrangements for accreditation, standards and measurements under a number of international and regional cooperation programmes. Such arrangements provided the recognition and acceptance of test and calibration analyses reports as well as quality certificates issued by conformity assessment bodies that were accredited by DSM.

S&T Human Resource

12.24 In line with the efforts to increase human resource with S&T knowledge and skills, the number of S&T graduates increased at an average annual rate of 25.3 per cent during the Plan period. As a proportion of total output, S&T graduates increased from 40.1 per cent in 2000 to 52.4 per cent in 2005, which increased the potential pool of research scientists and engineers (RSEs).

12.25 Recognising the need to enhance S&T capacity and capability, the S&T human resource development programme was implemented. A total of RM116 million was allocated to fund the National Science Fellowship (NSF), the Post-Doctoral Research Fellowship, Post-Graduate Grant Scheme for In-Service Personnel, Training Specialist and Consultant Grant Scheme and Attachment for Researchers. Another RM61 million was allocated to public institutions of higher education to fund post-graduate students in key technology areas.

III. PROSPECTS, 2006-2010

12.26 In an increasingly competitive global economy, the ability to leverage on STI will become strategically more important in national development. Rapid advancements and the pervasive role of STI in the global economy requires that the nation build upon and enhance its capability and capacity in STI in order to tap into potential wealth creating opportunities. Therefore, the Government will place greater emphasis on capacity building and strengthening the NIS to build upon leading-edge technologies and know-how. Towards this end, the target will be to increase national R&D expenditure to 1.5 per cent of GDP by 2010 with private sector expenditure of more than 70 per cent. In addition, measures will be undertaken to achieve the target of 50 RSEs per 10,000 labour force by 2010. A focused approach based on niche areas will be adopted to

build a critical mass of technopreneurs to increase the rate of commercialisation of R&D and create more S&T-based companies.

STI Development Thrusts

12.27 The thrust for STI development during the Ninth Plan period will be to contribute towards innovation-led growth as well as enhance productivity and competitiveness for wealth creation and social well-being. Efforts will be intensified towards mastering and harnessing S&T for widespread applications in generating knowledge, innovation and growth. In this regard, concerted efforts will be undertaken to implement the following strategies:

- ❑ *strengthening the NIS to contribute more effectively towards the development and diffusion of new technologies to enhance productivity, competitiveness and growth;*
- ❑ *enhancing S&T human capital as a principal source of innovation and competitive advantage;*
- ❑ *promoting technopreneurship to enhance national innovative capacity and increasing the number of S&T-based companies;*
- ❑ *enhancing technological capability and capacity of SMEs to meet the challenges of globalisation and increasing competition;*
- ❑ *prioritising and consolidating R&D and commercialisation initiatives to ensure more effective resource allocation and increase the rate of commercialisation of R&D and returns to investment;*
- ❑ *focussing on targeted R&D to generate new sources of growth;*
- ❑ *promoting standardisation and quality assurance for competitiveness and consumer well-being;*
- ❑ *increasing STI awareness to contribute towards nurturing a culture of creativity and innovation; and*
- ❑ *improving international linkages in STI development to tap global knowledge.*

Strengthening NIS

12.28 Recognising that the nation's growth potential increasingly hinges on the effectiveness of the innovation capacity and capability in creating, diffusing and using knowledge, a holistic approach will be adopted to strengthen the NIS. Towards this end, the National Innovation Council will be established to provide leadership in the formulation of policies and key strategies to stimulate innovation at national and firm levels and contribute to the development of dynamic innovative

clusters. The NIS Framework will take into consideration successful models and best practices of other technologically-advanced countries and adapt these to strengthen the NIS.

12.29 During the Plan period, efforts will be geared towards enhancing the capability of research institutions and universities to generate technologies required for product and process innovations as well as improving mechanisms for effective technology transfer. In this regard, R&D collaboration with the industry will be intensified to enhance productivity and technological development of companies as well as contribute towards the revenue of universities and research institutions. The universities will, however, continue to conduct fundamental research to provide the basis for advancement in scientific knowledge and technology applications. Consolidation of STI infrastructure will be undertaken to ensure optimum utilisation of available facilities and equipment. An evaluation of the technology parks, incubator centres as well as research facilities of universities and research institutions will be undertaken to increase their effectiveness to commercialise R&D and create spin-off companies.

12.30 Realising that financing is a key enabling factor for innovation, measures will be undertaken to increase access to financing and improve funding mechanisms. The R&D and commercialisation grant schemes will be augmented after taking into account the entire value chain of activities from research to market. This will be complemented by efforts to develop viable business and financing models for commercialisation of R&D findings. In addition, more venture capital will be mobilised to spawn high technology companies.

12.31 To further encourage innovation, technology transfer and commercialisation, the existing IP framework will be strengthened. Measures will be undertaken to enhance IP support facilities and shorten the IP approval process. The technology licensing offices of research institutions and universities will be strengthened. As part of efforts to increase the rate of commercialisation of public research findings, the mechanism on assignment of IP and sharing of royalties will be reviewed. This review will be aimed at, amongst others, to increase the uptake of R&D by industry as well as provide rewards for innovation and entrepreneurship.

Enhancing S&T Human Capital

12.32 Realising that human resource in S&T form the core of scientific discovery and innovation, efforts will be intensified to increase human capital investment and mastery of knowledge in accordance with the fourth principle of *Islam Hadhari*. To achieve the target of 50 RSEs per 10,000 labour force by the year 2010, measures will be undertaken to increase the number of RSEs at an average annual rate of 17.7 per cent. To generate demand for RSEs, centres of excellence in emerging technology areas will be set up and the R&D capacity of universities and research institutions will be upgraded. More technology-

based companies will be created and R&D collaboration between universities, research institutions and the private sector, particularly government-linked companies (GLCs) and multinational corporations (MNCs), will be enhanced.

12.33 As part of efforts to provide a more conducive environment to raise the level of interest in research work as well as to encourage innovation and commercialisation, researchers will be allowed to hold key positions and/or own equity in spin-off companies. A flexible mechanism to provide options for researchers to return to their former post at the relevant institutions will be considered. Upon reaching the retirement age, due consideration will be given to extend services of researchers in order to ensure completion of key R&D projects, as well as enable researchers with proven track record to continue contributing towards national R&D and innovation activities.

12.34 To optimise the utilisation of expertise and core competencies of RSEs, measures will be undertaken, particularly by public research institutions and universities, to increase the FTE of RSEs to 70 per cent. This will involve, among others, organisational restructuring to reduce their administrative workload and further improvements in the scheme of service for RSEs to enable them to be promoted and remain as researchers. These initiatives will be complemented by the move to designate selected public universities as research universities, which will contribute towards the increase in FTE and demand for researchers.

12.35 The S&T human resource development programme will be fine-tuned to ensure the development of key competencies in strategic research areas to meet national and industry needs. In this regard, a study on the S&T human resource requirements will be conducted and a directory for RSEs will be established to facilitate strategic planning as well as to ensure the development of a critical mass of RSEs in key technology areas. To increase the capacity and capability of R&D talent pool, dedicated centres of excellence for targeted areas of research will be established. This will be done by strengthening existing laboratories or institutes that have high potential and proven track records. These centres of excellence will be able to tap students of institutions of higher education to assist in research activities and provide employment opportunities for S&T graduates.

12.36 Post-graduate programmes will be given greater emphasis to provide the necessary support for R&D projects as well as enhance technology transfer and development. The curriculum of institutions of higher education will be continuously reviewed to improve the quality of science, engineering and management programmes. In addition, courses that combine hard technical, science and engineering subjects with soft skills development including management of technology and innovation programmes will be encouraged.

12.37 Considering that schools and education form the basic building block for S&T human resource, the S&T curricula at primary and secondary levels of education will be continuously reviewed to meet national and industry requirements as well as nurture a culture of innovation and creativity. In addition, efforts will be intensified to provide training to teaching professionals to enable them to keep abreast of the latest scientific and technological development.

12.38 To support the human resource requirements along the entire innovation value-chain, programmes will be put in place to develop an adequate number of technopreneurs, technology licensing officers and business managers. These programmes will be geared towards addressing the gaps in human resource with competencies and skills in risk assessment, technology evaluation and business management. In addition, the skills of supervisors, technicians and production workers will be upgraded, especially in handling advanced technological equipment and laboratory facilities.

12.39 To complement the initiatives of capacity building, the National Brain Gain Programme will be spearheaded by a focal point at the Ministry of Science, Technology and Innovation which will interface directly with RSEs abroad and coordinate the needs of the industry, research institutions and universities. In this regard, a mechanism and financial modalities will be put in place to facilitate the placement of top-notch overseas RSEs into positions, research projects and institutions that are suitable to their expertise as well as provide relocation support, where necessary. The RSEs could serve as mentors or guide selected R&D projects to accelerate technology transfer and enhance technological capability.

Promoting Technopreneurship

12.40 Technopreneurs and new technology-based enterprises are key agents in the NIS. In this regard, the technology incubator programme will be enhanced to develop a sustainable pool of indigenous technopreneurs and technology-based enterprises. It will be integrated into the broader strategy of enhancing the utilisation of new knowledge and technology produced by research institutions and universities for the development of new products and services. The incubators will place greater emphasis on nurturing services such as financial and risk management as well as IP management. In addition, networking and technical services will be provided.

12.41 The Government will work closely with the relevant industry associations involved in developing and nurturing entrepreneurs to further enhance the effectiveness of the incubator programmes as a key vehicle to promote technopreneurship. In this regard, efforts will be made to develop capacity and capability in incubator management and the promotion of best practices in incubator operations.

12.42 As part of efforts to nurture a Bumiputera S&T community for wealth creation, the technopreneurship development programme will be enhanced. In this context, Bumiputera RSEs will be provided with mentoring services such as technology evaluation and business plan development. Technology incubation and business matching initiatives will be intensified to commercialise R&D findings by Bumiputera RSEs through the establishment of start up companies or technology licensing.

Enhancing Technological Capability and Capacity of SMEs

12.43 During the Plan period, high priority will be accorded to strengthen the technological capability and capacity of SMEs to meet the challenges of globalisation and increasing competition. Towards this end, strategies will be directed at acquiring technologies that will propel SMEs up the value chain in the manufacturing, agriculture and services sectors. Increased emphasis will also be placed on technology development capabilities to establish technological leadership, achieve product and services differentiation as well as to create a greater number of local technology-based companies.

12.44 To fast-track domestic technology development capabilities of SMEs, specific programmes will be implemented to nurture local SMEs as R&D partners to tap the opportunities of R&D outsourcing by MNCs and GLCs. Measures will also be undertaken to encourage collaborative ventures among MNCs, GLCs and SMEs, to facilitate technology transfer and skills development as well as marketing. More targeted R&D projects will be undertaken by universities and research institutions in collaboration with SMEs.

12.45 During the Plan period, technopreneur development will be expanded to support S&T-based SMEs to benefit from homegrown technologies, particularly Bumiputera SMEs. This will be achieved through, among others, the provision of appropriate infrastructure, transfer of technology and better access to financing. New support mechanisms will be introduced to enhance outreach programmes for SMEs including technical, design, marketing and business advisory services.

Prioritising and Consolidating R&D and Commercialisation Initiatives

12.46 During the Plan period, efforts will be intensified to commercialise at least 10 per cent of the public-funded R&D projects. Towards this end, measures will be undertaken to strengthen and address existing gaps along the entire value chain of bringing innovative ideas to market. The R&D and commercialisation funding mechanism will be realigned to provide end-to-end financing and resources will be redirected towards more demand-driven R&D to increase the rate of commercialisation. This includes the setting up of the ScienceFund and TechnoFund as well as enhancements to the CRDF.

12.47 The ScienceFund is a R&D grant scheme, which will provide funding from basic research to the development of laboratory-scale prototype. The TechnoFund is a grant scheme to develop technologies for commercialisation. The scope of TechnoFund will include development of commercial-ready prototype, pilot plant and incubation activities to address the funding gap of pre-commercialisation activities.

12.48 The CRDF will continue to provide matching grants to increase the rate of commercialisation of R&D outcomes. As part of efforts to enhance the CRDF, higher value added nurturing services will be provided to the recipients. The CRDF will include a component for competitive bidding by universities and research institutions to conduct pre-feasibility studies on R&D results. This will enhance the marketability of public R&D findings and thereby increase the commercialisation potential.

12.49 In order to yield maximum benefits, well-designed mechanisms for effective management of R&D, generation of intellectual capital and commercialisation will be put in place. Greater emphasis will be directed towards conducting technology scanning, market intelligence and feasibility studies to guide research priorities and allocations to enhance value creation from investments in R&D. The participation of the industry and venture capitalists in the process of determining research priorities will be enhanced. The approval of R&D and commercialisation projects will take into account critical success factors such as technical and market feasibility, risk management, adequate human and financial resources, institutional support and viable commercialisation and business models.

12.50 To ensure the smooth progress and successful completion of projects, measures will be undertaken to strengthen the coordination, monitoring and evaluation of R&D and commercialisation of projects. In addition, suitable targets and milestones for R&D and commercialisation projects will be established to facilitate an objective and systematic assessment of these projects. The disbursement of funds at key milestone stages will be based on the achievement of these well-defined targets.

Promoting Targeted Technologies for New Sources of Growth

12.51 During the Plan period, greater emphasis will be placed on targeted R&D to build competence and specialisation in emerging technologies to generate new sources of growth. To avoid the spreading of resources too thinly across a broad range of areas, priority will be given towards developing a few niche areas. In this regard, focus will be directed at biotechnology, advanced materials, advanced manufacturing, ICT and nanotechnology to generate 300 S&T-based companies through public funded R&D and 50 companies with global partnerships. To fully harness the benefits of technology development, diffusion and application

in targeted growth areas, a cluster-based approach will be adopted and collaboration between the research community and industry players will be enhanced through improved mechanisms and processes.

Biotechnology

12.52 In moving forward, biotechnology will be positioned as a new growth area to enhance economic prosperity and social well-being. Towards this end, concerted efforts will be geared towards accelerating the development of the biotechnology industry based on the strategic thrusts and directions of the National Biotechnology Policy. Accordingly, the identified focus areas, namely, agricultural, healthcare and industrial biotechnologies will be developed by leveraging on the nation's strength and competitive advantage.

Information and Communications Technology

12.53 During the Plan period, greater efforts will be undertaken to leverage on ICT as an enabler to enhance productivity and competitiveness as well as a driver to harness new sources of growth. Towards this end, the technology focus areas that will be emphasised include semiconductors and microelectronics; Internet Protocol version 6 (IPv6), grid computing and language engineering; and information security.

12.54 *Semiconductors and Microelectronics.* As part of efforts to shift towards high value added activities, R&D will be directed towards development of IC design and advanced chips packaging. In this regard, micro-electro-mechanical systems (MEMS) design will be developed for the fabrication of various devices and applications such as radio frequency (RF) switches, resonators, accelerometers and sensors. R&D in mobile communications will be conducted to increase local content and applications to cellular users. The use of wireless broadband such as third generation (3G) and general packet radio service (GPRS) will further enable interactive applications development and enhance the growth of communications services.

12.55 *IPv6, Grid Computing and Language Engineering.* The anticipated migration from IPv4 to IPv6 will spur R&D activities in the areas of IPv6 compatible applications, quality and security, which are new features available within the IPv6 protocol. Grid computing will be given emphasis to facilitate advanced informatics research, which includes language identification, statistical techniques of data classification as well as various medical and biotechnology research.

12.56 *Information Security*. To realise the full potential of ICT, efforts will be intensified to mitigate the impact of information security threats and breaches. In this regard, areas of research in ICT security will be targeted at preserving e-sovereignty and establishing trust within e-commerce. Efforts will be undertaken

to develop affordable and effective authentication engines, secure communications, high availability systems, trusted identity, secure applications and trusted systems to ensure confidentiality, integrity and availability of information.

Advanced Materials and Manufacturing

12.57 Efforts will be intensified to develop new and improved advanced materials for applications by a diverse range of industries. The utilisation of *advanced materials* is expected to benefit industries by, among others, extending equipment life, reducing maintenance cost as well as increasing energy efficiency and reliability of products. The R&D focus areas for advanced materials include photonic materials for the telecommunications industry as well as metal and polymer composite materials for defense, aerospace, agriculture and automotive industries. Emphasis will also be directed at developing new materials for energy storage devices. Efforts will be geared towards promoting the use of advanced technologies, engineering, and processes to enhance competitiveness and create higher value added products. In order to support *advanced manufacturing* as a source of growth, R&D in areas such as control technologies, flexible manufacturing systems (FMS), computer integrated manufacturing (CIM) and advanced process engineering will be undertaken.

Nanotechnology

12.58 During the Plan period, R&D in nanotechnology will focus on areas with high potential for application in local industries. These include nanostructured catalysts for environment-friendly hydrocarbon fuels, nanostructured membranes for waste water treatment and MEMS for medical diagnostic devices. The R&D capacity in nanotechnology will be enhanced to develop a strong knowledge base among researchers to enable them to participate in international networks and leverage on the global knowledge.

Promoting Standardisation and Quality Assurance

12.59 Standards and conformance are critical tools to improve industrial efficiency and productivity as well as raise level of competitiveness of exports and acceptance by consumers. During the Plan period, the implementation of the National Standards Strategy and Action Plan will be expedited, particularly the development of relevant Malaysian standards. In addition, Malaysian standards will be harmonised with international standards to ensure acceptability of Malaysian products and services in overseas markets.

12.60 In response to industry needs, accreditation schemes will be further developed and expanded to include more areas such as electromagnetic compatibility (EMC), information security management system (ISMS) and Hazard Analysis and Critical Control Point (HACCP). The availability of these schemes

will enable conformity assessment bodies to expand their scope of certification and testing as well as seek accreditation, thus ensuring the credibility and competency of the services offered to industries. To provide wider support to industries to be global trade players, the Government will continue to seek acceptance into the relevant international accreditation bodies for mutual recognition arrangements of regional and international accreditation organisations in these expanded areas.

12.61 Malaysia will remain vigilant on the emergence of new instruments of trade and international business, which can impact the competitiveness of exports to the global market. In particular, the use of eco-labels and safety standards are expected to become mandatory in the face of growing concern over the environment and public health. In order to meet these requirements, the regulatory and institutional framework will be strengthened to implement an eco-labelling scheme, which identifies products that minimise the burden on the environment.

Increasing STI Awareness

12.62 As part of efforts to create a culture of creativity and innovation, focus will be directed at promoting greater awareness, interest and understanding of STI at all levels of society, particularly at the school level. Campaigns will be organised to increase awareness on the contribution of STI towards creating wealth and improving quality of life as well as encourage S&T as a preferred career choice. New approaches will be adopted to coordinate promotional activities by various government agencies, in collaboration with the private sector and non-governmental organisations (NGOs), to create a greater impact on targeted groups such as school children and rural population.

12.63 The exhibition gallery of the National Science Centre in Kuala Lumpur will be upgraded to include new exhibits to attract more visitors. A new regional science centre will also be established in Kedah. In addition, the dedicated programmes for schools, and children in rural areas to visit the science centres, will be expanded.

Improving International Linkages in STI Development

12.64 Given the increasingly interdependent global economy, international networking and collaboration will remain an important strategy to enhance capabilities in STI. In this regard, international strategic partnerships will continue to be forged to enhance sharing of knowledge and resources. The existing bilateral cooperation arrangements, covering ASEAN as well as other regional and multilateral cooperation programmes on S&T will be strengthened. The various memoranda of understanding and bilateral cooperation agreements will be translated into more beneficial outputs in the interest of STI development in Malaysia.

12.65 As part of efforts to tap global knowledge, a more coordinated effort will be undertaken to establish linkages with world-renowned institutions in targeted areas of excellence and competence. Towards this end, greater focus will be given to facilitate collaborative research programmes, research attachment, post-doctoral training and the hosting of international conferences in strategic fields. Malaysian researchers will be encouraged to participate actively in major global research programmes organised by regional and international S&T organisations.

IV. INSTITUTIONAL SUPPORT AND ALLOCATION

12.66 The Ministry of Science, Technology and Innovation is the lead agency in the implementation of the R&D and commercialisation programmes in collaboration with other key ministries and agencies. The Ministry of Higher Education and the relevant universities and training institutions will implement programmes to ensure an adequate supply of S&T human resource.

TABLE 12-3

DEVELOPMENT EXPENDITURE AND ALLOCATION FOR SCIENCE, TECHNOLOGY AND INNOVATION, 2001-2010
(RM million)

Programme	*8MP Expenditure*	*9MP Allocation*
Research and Development (R&D)	**926.6**	**1,581.6**
R&D Grant[1]	926.6	-
ScienceFund/Fundamental Research	-	1,581.6
Technology Acquisition Fund (TAF)	**70.7**	**142.5**
Commercialisation of Technology	**267.5**	**1,843.3**
Industry R&D Grant Scheme (IGS)	197.0	-
Commercialisation of Research and Development Fund (CRDF)	30.5	115.0
Technology Development and Incubator Programme[2]	40.0	228.3
TechnoFund	-	1,500.0
S&T Human Resource Development and Awareness	**123.1**	**650.6**
S&T Infrastructure	**1,950.0**	**1,035.1**
Total	**3,337.9**	**5,253.1**

Source : Economic Planning Unit

Notes: [1] Include IRPA, SAGA, Biotechnology R&D, Malaysia-MIT Partnership Programme and Oceanography R&D.
[2] Include MTDC and MDC programmes.

12.67 For the Ninth Plan period, an allocation of RM5.3 billion will be provided for STI initiatives to strengthen the NIS, as shown in *Table 12-3*. In line with the focus towards downstream R&D activities and commercialisation, 67.9 per cent will be allocated for R&D, technology acquisition and commercialisation of research. Priority will also be accorded to develop S&T human resource, raise awareness on S&T and provide S&T infrastructure and facilities.

V. CONCLUSION

12.68 During the Eighth Plan period, measures were undertaken to strengthen the S&T policy framework and infrastructure to enhance productivity and competitiveness. For the Ninth Plan period, a more holistic approach will be adopted to strengthen the NIS and move the economy up the value chain. Concerted efforts will be directed at raising the technology, knowledge and innovation content across all sectors of the economy. The emphasis will be placed on addressing the gaps along the entire value chain of bringing research ideas to market. To encourage private sector participation in innovation as well as product and market development activities, matching grants, venture capital and improved incentives for R&D and technology acquisition will be made available. The S&T human resource development programme will be implemented to ensure the development of core competencies in key technology areas for value creating activities and meeting industry needs. To support the establishment of new technology-based enterprises, efforts will be geared towards promoting technopreneurship and enhancing technology incubator programmes. The successful implementation of these programmes will necessitate the mobilisation of collaborative efforts among the Government, industry and relevant stakeholders in a synergistic manner to maximise STI potential as a principal driver to raise the nation's capacity for knowledge and innovation as stated in the second thrust of the National Mission.