CHAPTER 12 - SCIENCE AND TECHNOLOGY

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Chapter 12

Science and Technology

12 SCIENCE AND TECHNOLOGY

I. INTRODUCTION

12.01 During the Seventh Plan period, despite the economic slowdown, high priority was accorded to the promotion of science and technology (S&T), research and development (R&D) as well as technological innovation as an essential part of the Government's overall strategy of sustainable development. The core strategies of R&D, in particular, were focused on promoting value-added research activities that contributed to increasing competitiveness, strengthening linkages and enhancing productivity. The private sector, on its part, continued to contribute to the expansion of research activities and innovations, especially in the manufacturing sector.

12.02 Recognizing that scientific advances and technological changes are becoming increasingly important in developing a knowledge-based economy, emphasis will be given to support S&T development that promotes productivity-driven growth and provides for competitive advantage. This will entail the mastering of technology and knowledge and harnessing them for widespread application in all sectors of the economy. In this regard, the Government will facilitate and enhance further the collaboration of the public and private sectors in R&D activities so as to contribute to the development of a comprehensive national innovation system. Measures will be undertaken to restructure existing R&D institutions to undertake more market-oriented activities, promote technology applications in industry as well as expand and strengthen S&T manpower. At the same time, the creation of new institutions to expand the R&D base, particularly in new and emerging areas, will also be considered.

II. PROGRESS, 1996-2000

12.03 The S&T policy essentially supported the national development strategy of sustainable economic growth, accelerating industrial development and building

the foundation for the attainment of a scientific and technologically advanced society by the year 2020. The policy thrust was, in principle, based on the synergistic collaboration between the public and private sectors as well as with the scientific and technological community. The strategies and programmes evolved were aimed at widening and improving the S&T base and ensuring the development of competitive goods and services as well as building up the R&D and innovation capability of the nation. In particular, a number of measures were undertaken to improve the effectiveness of public sector and corporate R&D. These measures included providing incentives and funding, expanding human resource development and increasing protection for intellectual property rights. In addition, R&D agencies and universities undertook institutional and structural reforms to expand research facilities and improve the quality of S&T manpower.

Review of S&T Policy

12.04 Notwithstanding the progress made, it was recognized that the S&T policy needed to be continually reviewed and updated. Towards this end, in the later part of the Seventh Plan, a review of the S&T policy was initiated. Its major objective was to prepare a framework as well as operational strategies to meet the demands of a rapidly changing global economy which is innovation- and technology-driven. The on-going review provided the basis for the reassessment of the current S&T system as well as the formulation of an action plan to accelerate the development of Malaysia's capacity and capability in S&T knowledge and skills within the context of increasing the information and knowledge content in all economic activities.

12.05 Among the strategies recommended were the need to intensify knowledge generation and acquisition as well as building S&T capacity and capabilities for the future through the development of enabling and platform technologies and intensifying knowledge content in all economic activities. There was also a need to enhance competitiveness in industry, particularly through building indigenous technological capability in new enabling technologies. As science and technology increasingly became infused into the industrial development of the country, it was recommended that the S&T inter-governmental cooperation and coordination mechanism be strengthened to ensure coordination between S&T policies and other economic development policies. Other recommendations included the promotion of a stronger S&T and innovative culture, establishment of international linkages to gain access to advanced S&T information, and the development of an effective performance measurement and monitoring mechanism.

National R&D Expenditure

12.06 The biennial surveys on R&D expenditure conducted by the Government, recorded a more than double increase in the amount spent on R&D from RM549.1 million in 1996 to RM1.1 billion in 1998. As an indication of Malaysia's R&D efforts, the proportion of R&D expenditure to the Gross Domestic Product (GDP) increased from 0.2 per cent to 0.4 per cent over the corresponding period. While this might be considered low, it was encouraging to note that the number of responding organizations with R&D activities increased from 196 to 273, accounted mainly by the private sector.

12.07 In terms of types of research, continued emphasis was given to applied research and developmental research, which together accounted for about 90 per cent of the R&D expenditure. Basic research accounted for the balance of the R&D expenditure. There was, however, a decline in the proportion spent on developmental research from 49.4 per cent in 1996 to 37.2 per cent in 1998, indicating the cautious attitude of the private sector in the light of the economic slowdown.

12.08 From an economic perspective, overall R&D efforts were concentrated in manufacturing, information and communications technology (ICT) services, plant production and primary products, followed by energy resources. For the public sector, there was a shift in focus of R&D activities from agricultural sciences towards ICT. Meanwhile, the private sector, continued to focus on the manufacturing industries, particularly in electronic equipment and components, transport equipment as well as petroleum products and refining.

12.09 In spite of the economic slowdown, R&D expenditure by the private sector increased from RM400.1 million in 1996 to RM746.1 million in 1998. The surveys indicated that the R&D expenditure of local companies were distributed over a wide range of industries while the foreign companies focused on high-technology related industries such as the electronic equipment and components as well as computer-related services. However, there was still a heavy reliance on foreign R&D capability as reflected by the substantial number of R&D activities sourced from abroad. Factors that hindered R&D initiatives included, among others, the lack of skilled R&D personnel, limited financial resources and lack of infrastructure for R&D.

12.10 The growth in the private sector R&D expenditure reflected the positive response to incentives provided by the Government. Incentive schemes included

double deduction expenditure incurred for R&D, pioneer status for companies involved in R&D and investment tax allowance (ITA) of up to 100 per cent of qualifying expenditure. However, the uptake of the incentives was mainly for double deduction expenditure incurred for R&D. The number of projects approved increased from 247 in 1995 to 387 in 1998 with a corresponding value of RM42.2 million and RM51.4 million, respectively. In 1999, there was a substantial increase in the number of approvals totalling 531 projects valued at RM279.2 million. During the Plan period, a total of 50 companies was granted pioneer status or ITA for in-house R&D activities as well as R&D for other companies. The capital expenditure of these companies amounted to RM844 million and were mainly in the electrical and electronics products and transport equipment industries.

Public Sector Expenditure on R&D Programme

12.11 The Government continued to place emphasis on R&D as reflected by the increase in the total budgetary allocation for the public sector involvement in R&D. During the Seventh Plan period, a sum of RM935 million was allocated for the R&D programme compared with RM629 million in the Sixth Plan. Of this, RM755 million was allocated for direct public sector involvement in R&D through the Intensification of Research in Priority Areas (IRPA) programme. For the development of biotechnology, a sum of RM35 million was allocated for the partnership programme with the Massachussetts Institute of Technology (MIT). The balance was provided for the funding of three new schemes to enhance private sector R&D. These schemes included the Industrial Research and Development Grant Scheme (IGS), MSC Research and Development Grant Scheme (MGS) and the Demonstrator Applications Grant Scheme (DAGS).

12.12 The management of the *IRPA* mechanism, at the institutional and implementation levels, was revamped to ensure that scarce research funds were channelled to more applied and industry-relevant projects. Research agencies and universities competitively bid for funds to ensure that the best proposals were selected while reducing overlaps and duplication of research activities. The number of research priority areas were expanded from five to 11 in order to support the development of enabling technologies in line with the requirements of the Second Industrial Master Plan (IMP2) and the advancement of ICT as a key sector of the economy. To ensure better coordination in R&D activities and optimum utilization of research resources, the budgetary allocation was centralized at the Ministry of Science, Technology and Environment (MOSTE).

12.13 Under the IRPA programme, a total of 3,705 projects valued at RM698.3 million was approved, as shown in *Table 12-1*. In addition to competitive bidding, a targeted approach for technology development was undertaken for the advancement of strategic technologies such as biotechnology and photonics. In general, the pattern continued to be similar to that in the previous Plans, mainly due to the high R&D capacity in agriculture compared with capacity in manufacturing, ICT and services.

12.14 An assessment of the benefits and effectiveness of the research funded under IRPA indicated that the extent of commercialization of R&D findings remained low across all sectors. There were few takers of potential technologies and products as the private sector wanted to minimize their risks on untried and untested technologies and products in the market. In addition, linkages with industry through joint or collaborative R&D were still negligible, thus reflecting the need to coordinate closely with the private sector to generate more market-oriented R&D projects.

TABLE 12-1

IRPA PROGRAMME APPROVALS BY AREA OF RESEARCH, 1996-2000

Area	*Projects Approved*		*Value*	
	Number	*%*	*RM million*	*%*
Agro-Industry	1,255	*33.9*	178.67	*25.6*
Construction	95	*2.5*	23.76	*3.4*
Energy	134	*3.6*	37.27	*5.3*
Environment	164	*4.4*	46.97	*6.7*
Information and Communications Technology	110	*3.0*	34.95	*5.0*
Manufacturing	321	*8.7*	71.77	*10.3*
Medical	548	*14.8*	96.99	*13.9*
Material and Geoscience	37	*1.0*	14.97	*2.1*
Science Engineering	725	*19.5*	114.50	*16.4*
Services	66	*1.8*	14.97	*2.1*
Socio-Economic	212	*5.7*	16.08	*2.3*
Biotechnology	32	*0.9*	28.84	*4.1*
Photonics	6	*0.2*	18.54	*2.7*
Total	**3,705**	***100.0***	**698.28**	***100.0***

12.15 Recognizing the importance of *biotechnology* as the new emerging technology, a national biotechnology programme was formulated to develop and strengthen domestic R&D capacity and capability. Under the R&D component, seven areas of biotechnology were identified, namely, plant, animal, medical, industrial/ environmental, food, biopharmacy and molecular biology. To implement research work, biotechnology cooperative centres (BCCs) were established for each biotechnology area. The BCCs facilitated collaborative research in 12 identified projects through a network of researchers from the public sector and industries. In addition, four developmental research projects were undertaken to facilitate the development of products and processes for commercialization.

12.16 To accelerate the development of domestic R&D capability and capacity in biotechnology, partnership programmes were initiated to facilitate the transfer of technology through collaborative projects with international organizations. The Malaysia-MIT Biotechnology Partnership Programme (MMBPP) was launched in 1999 to build the foundation for the development of a sustainable biotechnology industry. The MMBPP capitalized on the platform technologies available in MIT and Malaysian expertise in tropical agroforestry and plant biology to develop high value-added palm oil products and herbal-based natural products.

12.17 In order to encourage private sector R&D, the *Industrial Research and Development Grant Scheme* (IGS) was established in March 1997 with an initial allocation of RM100 million. Its key feature was the fostering of collaboration among private sector companies, universities and research institutes applying for the grant assistance. By the end of the Seventh Plan period, a total of 58 projects valued at RM138 million was approved. These projects included adapting existing technologies and the creation of new products and processes. A total of four projects was completed and commercial trial runs indicated that these projects could be upgraded for market production.

12.18 As part of the efforts to promote R&D in the Multimedia Super Corridor (MSC) in order to create innovative multimedia products, processes and services, the *MSC Research and Development Grant Scheme* (MGS) was launched in April 1998 with an initial allocation of RM100 million. MSC-status companies with at least 51 per cent Malaysian ownership were eligible to apply for the grant which provided funding for one-half of the project cost relating to research over a two-year period. Since its launch, a total of 19 projects with a value of RM38 million was approved. The projects involved the development of software for electronic payment, computer telephony integration, fingerprint identification

product and new tools for the production of a newer generation of semiconductor equipment.

12.19 The *Demonstrator Applications Grant Scheme* (DAGS) was established in April 1998 as part of the efforts to promote widespread usage of ICT among Malaysians. The initial allocation was RM50 million and it provided an opportunity for Malaysians to create software and contents that were indigenous in design, local in content, and customized to the needs of the local community. By the end of the Plan period, a total of 37 projects valued at RM48 million was approved.

Industrial-based Technologies and Emerging Industries

12.20 Recognizing the importance of efficient technology management in building domestic technological capability to enhance industrial competitiveness, the National Technology Mapping Programme (NTMP) was initiated to identify long-term technology development targets. The NTMP was to support the IMP2 in developing sustainable and high value-added industries. Under Phase I of the NTMP, action plans were prepared outlining the core competencies and critical technologies required in the value chain of the telecommunications and pharmaceuticals industries.

12.21 To enhance indigenous capability in the electronics industry, efforts were taken to expand and upgrade the semiconductor technology programme which involved R&D and training in wafer fabrication and integrated circuit design. Phase I of the programme, implemented by MIMOS Berhad, became operational in May 1997 with a monthly production of 600 six-inch wafers using 1.0 micron Complementary Metal Oxide Silicon (CMOS) technology.

12.22 As part of the efforts to develop the aerospace industry and space technology, the microsatellite programme was formulated to provide the catalyst in developing domestic capability and manpower in satellite technology. The programme involved the design, construction and launching of a microsatellite for research in remote sensing and orbital positioning. A microsatellite named TiungSAT1 was designed and built in collaboration with the University of Surrey, United Kingdom under a technical programme which provided technology transfer to a team of Malaysian engineers and scientists. With the launching of TiungSAT1 in September 2000, it will facilitate R&D in space technology such as development of sensors and on-board computer systems as well as cosmic-ray energy deposition experiment. In terms of applications, the remote sensing capability of TiungSAT1

provided satellite imageries for meteorology, disaster management and pollution monitoring.

Technology Inflows

12.23 While the primary concern was to build and develop a stronger indigenous base, the transfer of technology from abroad continued to be important. The inflow of technology as indicated by the number of contractual agreements approved by the Government during the Seventh Plan period, is shown in *Tables 12-2* and *12-3*. However, this indicator is reflective of only those agreements required under the Industrial Coordination Act (ICA) 1975 or the Promotion of Investment Act (PIA) 1986 or when specifically required under any Foreign Investment Committee (FIC) rulings.

12.24 The composition of technology imports by industry reflected the expanding investments in high value-added and technology-intensive industries. The highest number of technology transfer agreements was in the electrical and electronics product industry, followed by the transport equipment industry and chemicals and chemical products industry. Recognizing the need for technology imports to accelerate industrial growth, the Government simplified the approval process by granting automatic approval to technology agreements that involved a royalty payment of 3.0 per cent or less of net annual sales.

12.25 During the Seventh Plan period, the deficit in the payments on royalties and fees continued to widen, indicating the relative importance of sourcing technology from overseas. Payments for technology acquisition from abroad registered a growth of 11.7 per cent per annum during the Seventh Plan period, from RM932 million in 1995 to RM1.6 billion in 2000. These were royalties and fees mainly for the procurement of franchises, use of international brand names and payment of licences for the utilization of new and improved technologies. The various payments were reflected as outflows in the services account of the balance of payments.

Standardization and Quality Assurance

12.26 In line with the national strategy to sustain and enhance the competitiveness of exports, efforts were continued to further improve industrial efficiency and productivity through national standards development, testing, measurements and international standardization. During the Seventh Plan period, a total of 680 Malaysian Standards consistent with international standards, was developed compared with 528 during the Sixth Plan. To accelerate the pace of standards

Table 12-2

TECHNOLOGY INFLOWS BY INDUSTRY GROUP, 1995 - 2000
(number)

Industry	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*7MP*		*6MP*	
							Number	*%*	*Number*	*%*
Food Manufacturing	2	0	5	1	4	2	12	*2.1*	23	*3.3*
Electrical & Electronic Products	32	54	28	50	43	48	223	*39.4*	221	*31.7*
Paper, Printing & Publishing	4	1	0	1	0	1	3	*0.5*	14	*2.0*
Beverages & Tobacco	1	0	1	1	6	5	13	*2.3*	11	*1.6*
Textiles & Textile Products	3	0	2	0	2	2	6	*1.1*	18	*2.6*
Furniture & Fixtures	0	0	0	0	1	0	1	*0.2*	10	*1.4*
Chemical & Chemical Products	22	12	2	21	18	25	78	*13.8*	89	*12.8*
Petroleum Refineries & Products	2	1	0	7	6	3	17	*3.0*	22	*3.2*
Rubber Products	3	9	2	2	6	2	21	*3.7*	30	*4.3*
Plastic Products	7	7	0	0	6	12	25	*4.4*	32	*4.6*
Non-Metallic Mineral Products	2	3	3	1	2	5	14	*2.5*	33	*4.7*
Basic Metal Products	0	0	1	4	3	5	13	*2.3*	18	*2.6*
Fabricated Metal Products	4	6	4	2	5	5	22	*3.9*	38	*5.5*
Machinery Manufacturing	4	6	12	7	5	1	31	*5.5*	19	*2.7*
Transport Equipment	9	15	23	10	15	15	78	*13.8*	99	*14.2*
Miscellaneous	7	2	3	0	4	0	9	*1.6*	20	*2.9*
Total	**102**	**116**	**86**	**107**	**126**	**131**	**566**	***100.0***	**697**	***100.0***

TABLE 12-3

TECHNOLOGY INFLOWS BY TYPE OF AGREEMENT, 1995-2000
(number)

Type of Agreement	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*7MP*		*6MP*	
							Number	*%*	*Number*	*%*
Joint-Venture	4	6	0	1	2	0	9	*1.6*	31	*4.4*
Technical Assistance	44	58	58	56	80	78	330	*58.3*	349	*50.1*
Licences & Patents	23	31	6	27	20	28	112	*19.8*	138	*19.8*
Knowhow	5	3	5	5	4	4	21	*3.7*	69	*9.9*
Trade Mark	3	9	5	11	15	15	55	*9.7*	41	*5.9*
Management	4	1	2	1	0	0	4	*0.7*	12	*1.7*
Turnkey & Engineering	1	0	0	0	0	0	0	*0*	9	*1.3*
Services	6	2	4	2	2	6	16	*2.8*	27	*3.9*
Sales, Marketing/Distribution	2	0	0	0	0	0	0	*0.0*	1	*0.1*
Supply & Purchase	0	0	1	1	0	0	2	*0.4*	0	*0.0*
Others	10	6	5	3	3	0	17	*3.0*	20	*2.9*
Total	**102**	**116**	**86**	**107**	**126**	**131**	**566**	***100.0***	**697**	***100.0***

development, two industry associations were appointed as standards writing organizations in the timber as well as the electrical and electronics industries. Testing facilities and services were expanded to ensure compliance to national and international standards. In addition, SIRIM Berhad established the Metals Performance Technology Centre to provide failure analysis and non-destructive testing services for the oil and gas, petrochemical, power generation and automotive industries.

12.27 Realizing the importance of implementing internationally accepted quality management for recognition in the international market, there was an increasing trend in the number of local companies adopting the ISO 9000 series of standards. During the Seventh Plan period, a total of 1,389 companies was successfully certified for ISO 9000 series of standards compared with 717 in the Sixth Plan period. In order to ensure international credibility of certification and laboratory accreditation, the Government took part in regional and international standardization activities. In this regard, Malaysia participated actively in the various ISO Technical Committees and was a member of the ISO Council for the term 1999-2000. In addition, the accreditation system was recognized by the International Accreditation Forum and facilitated the acceptance of certification of quality management in 24 countries.

S&T Manpower

12.28 An analysis of the output of graduates for the period 1991-2000 indicated that there was a doubling in absolute terms, of science and technical graduates in the Seventh Plan period compared with the Sixth Plan, as shown in *Table 12-4*. For the science students, there was a shift of emphasis from the pure sciences to more applied science-oriented disciplines such as engineering and computer technology. As a proportion of total output, technical graduates indicated a significant increase from 13 per cent to 16.2 per cent.

12.29 Notwithstanding the increasing trend in the output of science and technical graduates, the pool of researchers need to be expanded further. The biennial surveys on R&D expenditure showed that the number of research personnel involved in R&D activities increased by 31.3 per cent from 9,136 in 1996 to 12,127 in 1998. This gives a ratio of 5.1 and 7.0 researchers per 10,000 labour force, respectively. While the ratio improved, it was considered low compared with the countries in the Organization of Economic Cooperation and Development (OECD).

TABLE 12-4

OUTPUT OF DEGREE COURSES[1], 1991-2000

Course	*6MP*		*7MP*		*8MP[2]*	
	Number	*%*	*Number*	*%*	*Number*	*%*
Arts & Humanities including Economics, Business & Law	49,018	*62.0*	87,882	*58.4*	161,102	*48.4*
Science including Medicine, Agricultural Science, Pure Sciences & Others	19,642	*25.0*	38,273	*25.4*	100,967	*30.4*
Technical, Engineering, Architecture, Surveying & Others	10,508	*13.0*	24,343	*16.2*	70,650	*21.2*
Total	**79,168**	***100.0***	**150,498**	***100.0***	**332,719**	***100.0***

Notes:
[1] Output for First Degree, Masters, Ph.D and post-degree Diploma
[2] Estimates

12.30 As part of the efforts to expand the S&T human resource base, the Government implemented the S&T human resource development programme. In this regard, a fund of RM300 million was set up to provide scholarships for post-graduate and post-doctoral studies as well as fellowships for graduate research. A total of 1,791 scholarships was given out to public sector researchers and officers for training in priority areas such as advanced materials and manufacturing, ICT, microelectronics, energy and environment. In addition, the National Science Fellowship scheme awarded 298 scholarships to graduates in science, engineering and technology to pursue post-graduate studies by research in the identified priority areas.

12.31 To accelerate the rate of technology transfer and upgrade indigenous R&D capabilities, the Government initiated a programme to bring back Malaysian scientists and engineers working overseas as well as allow local research institutions and universities to employ foreign R&D personnel, where necessary. A total of 23 Malaysian and 70 foreign scientists was brought in to work in the various research institutions and universities. These scientists were mainly involved in medical research, engineering as well as semiconductor and laser technology.

Commercialization of Research and Technology

12.32 While public sector R&D activities contributed to technical improvements, the progress on the commercialization of such output was limited. This was largely due to problems related to the lack of industry-relevant R&D projects and finance to fund the various stages of commercialization from the laboratory to the market place. A survey of 5,232 projects implemented by the public research institutions and universities during the Sixth and Seventh Plans revealed that 14.1 per cent of these projects were identified as potential candidates for commercialization while only 5.1 per cent was commercialized. However, a recent assessment of R&D undertaken in the primary commodity subsector indicated that the percentage of commercialization of R&D in industrial agricultural commodities was 8.9 per cent. In this regard, the palm oil sector contributed the highest commercialization rate of 12.1 per cent.

12.33 In 1997, the Commercialization of Research and Development Fund (CRDF) was launched with an allocation of RM100 million. The focus of the Fund was on the commercialization of R&D findings undertaken by local universities and research institutions as well as companies and individual researchers and inventors. During the Seventh Plan, 38 projects with a value of RM32 million were approved. Out of this, 12 projects had completed the commercialization process and their products were available in the market.

S&T Awareness and Promotion

12.34 Activities aimed at promoting greater interest, awareness and understanding of S&T were organized at various levels throughout the Seventh Plan period. These activities which involved scientists, journalists, students and members of the public included scientific conferences and exhibitions, S&T excellence awards, educational visits and workshops. In particular, national science essays and poetry competitions, use of computer software competitions as well as science and environment camps were organized at the school level. The National Science Centre, in addition to its theme-based interactive exhibits and events, organized the Students Adoption Programme in order to popularize and promote S&T, especially among the school children. These efforts in stimulating interests in science and technology were complemented by the activities of PETROSAINS, an interactive science discovery centre, established by *Petroliam Nasional Berhad* (PETRONAS).

12.35 The biennial National S&T Awareness Surveys of 1996 and 1998 showed that Malaysians continued to recognize the role and benefits of S&T in the growth and development of the economy. The surveys also indicated that Malaysians adopted a long-term outlook in scientific research and were aware of the need for research to be an on-going process. In terms of interest in S&T, it was observed that in general, the youths represented by the 15 to 20 age group registered the highest level of interest followed by the adults and children. It was also encouraging to note that children had a higher interest than the adults in aerospace exploration and application of computer technology. While there was an expressed interest by the younger generation in S&T, there was a need for more effective strategies to sustain this interest and promote S&T-related occupations as a career choice.

III. PROSPECTS, 2001-2005

12.36 The global economy is undergoing rapid development into a knowledge-based economy where technology, skills and innovation will be the determinants to enhance competitiveness and efficiency. Taking cognizance of this, the Government will continue to accord high priority on innovation-driven and technology-led development. With the economy projected to grow at 7.5 per cent per annum, the contribution of Total Factor Productivity (TFP) is expected to be 37.2 per cent of the growth target. Improvements in skills and management, expansion of R&D spending as well as greater use of technology and ICT in all sectors of the economy are expected to make significant increases in TFP.

The Thrust for S&T Development

12.37 The thrust for S&T development under the Eighth Plan will be to meet the objectives of productivity-driven growth and competitiveness of the economy. The Plan period will witness the increasing use of information and knowledge to generate economic growth. Considering that S&T-based development is expected to contribute more than one-third of the economic growth target, greater emphasis will be placed on optimizing the application of new and improved technology. This will be complemented by increasing indigenous innovation capability and accelerating the strategic development of industrial technology. The focus will be to provide an enabling environment for technology development through:

- ❑ *adopting an integrated national approach in the use of R&D resources in order to ensure more effective and efficient implementation of research and innovation projects;*

- *accelerating the rate of commercialization of R&D findings;*
- *enhancing further private sector involvement and commitments in R&D activities;*
- *increasing the supply of scientific and technological manpower;*
- *acquiring new and imported technologies through, among others, acquisition of equity in foreign companies and forging strategic alliances;*
- *promoting development of indigenous S&T capabilities in strategic and key technologies; and*
- *improving and expanding technical extension services and training to strengthen the technological capability of the small- and medium-scale enterprises (SMEs).*

Adopting an Integrated National Approach in the Use of R&D Resources

12.38 The country will support R&D and technology that will promote growth, enhance industrial efficiency, productivity and competitiveness, generate home-grown technology with own brands of goods and services and improve the quality of life. Within this context, public sector funding of R&D will focus more on the potentials for commercialization of research findings. For the Eighth Plan, a sum of RM1.6 billion will be allocated for R&D and commercialization of technology compared with RM1 billion during the Seventh Plan.

12.39 To ensure that research projects will contribute more to the needs of the country, the Intensification of Research in Priority Areas (IRPA) funding mechanism will be realigned and finetuned to place more emphasis on the development of innovations and further improve the commercial relevance of R&D projects. Priority setting will be increasingly used in project identification and implementation. In this regard, 35 per cent of the IRPA budget will be allocated to prioritized research in manufacturing, plant production and primary products, ICT, health as well as education and training. The focus will be on development of home-grown products, processes and related services for commercialization. Another 35 per cent will be for strategic research areas to enhance future competitiveness in emerging areas such as optical technology, specialty fine chemicals technology, design and software technology as well as nanotechnology and precision engineering.

The development of such national R&D projects will involve multi-disciplinary and multi-institutional research teams, including participation from the private sector as well as sharing of facilities and equipment. To ensure the effective implementation of the R&D projects, the monitoring and evaluation capacity will be strengthened.

12.40 Apart from the prioritized national projects, the on-going competitive bidding process by R&D institutions will be continued. This is to ensure that resources for research are utilized more efficiently and generate maximum socio-economic benefits. The R&D resources under IRPA will also provide for selected prototyping and pilot-scale testing. This will facilitate and accelerate the process of commercialization of research findings in the areas of agriculture and food security, natural resources and environment as well as manufacturing and services.

12.41 In addition, government research departments, research institutions and universities will proceed with their mission-oriented R&D. This includes basic R&D for knowledge advancement and build-up of fundamental strengths required by research agencies and universities to handle core technologies such as biotechnology, advanced materials and microelectronics. In particular, an allocation of RM100 million will be provided to universities to undertake basic research.

Accelerating the Rate of Commercialization of R&D Findings

12.42 Measures will also be undertaken to increase the rate of commercialization of R&D findings. In this regard, the business units at the research institutions and universities will be reorganized and strengthened to facilitate identification and implementation of market-oriented R&D projects through interaction among researchers and the private sector. To generate more R&D projects that can be commercialized, research institutions and universities will be encouraged to place more emphasis on research related to product and process development for the industries. In this regard, the incentive scheme in the commercialization of R&D findings will be reviewed. The existing grant schemes for private sector R&D such as the Industrial Research and Development Grant Scheme (IGS), MSC Research and Development Grant Scheme (MGS) and Demonstrator Applications Grant Scheme (DAGS) will be reviewed to strengthen the commercialization potential of the projects. To facilitate commercialization of the R&D findings and technology, a sum of RM610 million will be allocated. In addition, fiscal incentives will be provided to encourage venture capital funds to invest in start-ups involved in indigenous technology.

Further Enhancing Private Sector Participation in R&D Activities

12.43 Technology development and R&D by the private sector will continue to be supported by the Government through incentives and financial assistance. In this regard, existing fiscal incentives will be reviewed to promote greater

private sector participation in R&D activities. The various financial grant schemes for private sector R&D will also be expanded. In addition, industry associations will be encouraged to set up research facilities and, for this purpose, financial assistance will be considered.

12.44 The allocation for IGS will be increased to RM200 million in the Eighth Plan. Consideration will also be given towards designing a more comprehensive package for implementation, including major components such as research, prototyping and product development for commercialization. The allocations for MGS and DAGS will also be increased to RM200 million and RM100 million, respectively.

Increasing the Supply of S&T Manpower

12.45 To further develop innovative capability, the Government will increase its investment in scientific and technological education as well as in the development of technical and research manpower. In this regard, enrolment in the S&T degree programmes in local tertiary institutions will be increased towards achieving the 60:40 ratio of science to arts students. Emphasis will also be placed on continual updating of the S&T curricula and skills development to incorporate appropriate application-based scientific and technological knowledge.

12.46 Measures will also be stepped up to increase the pool of S&T and research personnel. The S&T human resource development programme, which provides scholarships for post-graduate and post-doctoral studies as well as fellowships for graduate research, will be reviewed to ensure a more balanced emphasis on both S&T education as well as practical R&D. The programme for attracting Malaysian scientists and engineers residing overseas will be enhanced with a revised incentive package which includes granting of permanent resident status to the immediate family, tax exemption on income remitted to Malaysia within a period of two years and tax exemption on all personal effects brought into Malaysia. In addition, measures will be taken to appoint Malaysian experts in S&T related areas who are working overseas to undertake short-term assignments in Malaysia such as teaching and lecturing, consultancies and research in specialized areas. A mechanism will also be instituted to ensure a more systematic identification of skills and expertise required to build up the indigenous capability in strategic and key S&T areas.

12.47 To further enhance the research culture within institutions of higher learning, collaboration with the private sector will be further strengthened. It is vital to develop more systematic linkages with industries in undertaking market-oriented research. Closer collaboration can lead to research breakthroughs with commercial value. In this regard, corporations will be encouraged to work with

researchers on attachment as part of the hands-on research training. This will form part of the Government's efforts in linking universities and entrepreneurs willing to invest in research endeavours.

Acquiring New and Imported Technologies

12.48 A major thrust will be the acquisition of strategic and key technologies and applications from abroad. This will assist in expediting the build-up of domestic capabilities in new technologies and innovative ideas. For this purpose, existing venture capital funds will be strengthened and new ones established. A venture capital fund to invest in selected international technology companies abroad such as those in the Silicon Valley will be established. To assist in the build-up of domestic R&D capabilities, a technology transfer programme will be formulated which includes placement of Malaysian technical personnel in acquired technology-based companies, direct involvement in product conceptualization and development as well as relocation of foreign-based manufacturing and R&D facilities in Malaysia. Other forms of technology acquisition include joint-ventures, outright purchase and strategic alliances.

12.49 To complement on-going efforts in technology acquisition, opportunities will be created to gain access to new technologies through institutions such as MIMOS Berhad. This will include, among others, participation in foreign venture funds specializing in technologies related to ICT and the life sciences. This strategy will enable the country to identify and create new business enterprises, jointly or singly, in new business technology.

12.50 In the effort to further facilitate the acquisition of technology in strategic industries, the allocation for the Technology Acquisition Fund (TAF) will be increased to RM250 million. The Fund will be made available for the purchase of high-tech equipment and machinery, technology licensing as well as acquisition of patent rights, prototypes and designs to enhance the transfer of technology to local companies.

Promoting Development of Indigenous S&T Capabilities in Strategic and Key Technologies

12.51 While imported technology will continue to be important in critical areas, increasing emphasis will be placed on raising the level of domestic innovation capability. The focus will be on increasing the core competencies in the application

of critical technologies in economic sectors. In this regard, the role of existing research institutions will be reviewed, particularly in view of the rapid changes in technology.

12.52 In order to support the implementation of technology-based industrial strategies under IMP2, Phase II of the National Technology Mapping Programme (NTMPII) will be undertaken. The goal will be to increase the domestic capability in undertaking the activities required in the value chain of, among others, wood-based products in the resource-based industry, food products in the agro-based and food products industry, and the machinery and equipment industry. NTMPII will also include international and domestic benchmarking by reviewing existing technology level and future directions, especially in terms of skills and investments required.

12.53 In order to promote and support the development of the electrical and electronics products industry, the indigenous R&D capability will be further enhanced with the expansion and upgrading of the MIMOS Berhad wafer fabrication facility to sub-micron technology and design capability. This will provide the base for the development of new products with high market potential, especially in digital signal processing and flash memory. The web-based design lab of Phase 2 is expected to facilitate web-based collaborative design through sharing of design skills and business opportunities among domestic producers in the electronics industry.

12.54 Global trends indicate that innovation in biotechnology is one of the key technologies for the 21st century. Modern biotechnology brought about by developments in genomics and molecular biology will provide the catalyst for the production of novel products for commercial application in areas such as medicine, fuel production, farming and food preparation. Recognizing this development, Malaysia will need to build up its R&D base to harness the use of biotechnology in order to create value from the nation's megabiodiversity of natural resources. In addition, this will provide a spin-off for the establishment of related high value-added industries such as pharmaceuticals, nutraceuticals and agro-biotechnology.

12.55 To intensify biotechnology R&D, the national biotechnology programme will continue to emphasize on prioritized and experimental research. In this regard, a sum of RM100 million will be allocated for research in the fields of agro-biotechnology, health care, and environmental and energy management. Initiatives will be taken to identify and formulate research programmes in genomics and molecular biology, pharmaceutical and nutraceutical biotechnology as well

as agro-biotechnology. A national biotechnology policy will be formulated for a more comprehensive and coordinated approach for the advancement of biotechnology as a strategic technology in the development of the economy. In addition, consideration will be given to establishing a Bio-Valley to provide for more integrated development of the biotechnology industry. The Bio-Valley is expected to create a conducive environment for the introduction and synergistic expansion of biotechnology industries along the various stages of the value chain.

12.56 For the next phase of development in ICT and multimedia, it is envisaged that the application of lightwave communications technology or photonics will revolutionize the communications system. Recognizing this, efforts will be taken to build on the IRPA research on photonics initiated during the Seventh Plan. The research project aimed at developing an all-optical network based on Wavelength Division Multiplexing-Fibre To The Home (WDM-FTTH) will help to spur numerous spinoffs to the SMEs in the manufacture of photonic components such as optical devices and switches. This will facilitate Malaysia to acquire an important technology in the area of lightwave communications which is the backbone for broadband multimedia platform.

12.57 The increasing capability of low-power microelectronics has enabled the development of highly capable Near Equatorial Low Earth Orbit (NeqO) satellites for remote sensing and communications. These satellites are more compact and economical than the conventional polar orbit satellites. Although there are many remote sensing satellites in operation, there are none in the equatorial orbit plane. Recognizing the opportunity for developing a niche market in the design, building and launching of the NeqO satellites, a detailed study will be undertaken. The study will also look into the potential commercial linkages with industries and services.

12.58 To facilitate a coordinated approach in the development of space and satellite technology, a national space agency will be established with the integration of the Malaysian Centre for Remote Sensing (MACRES) and Space Science Studies Division (BAKSA) of MOSTE. The new agency will be responsible, among others, for the formulation and implementation of the National Space Policy and the National Space Programme. Focus will be given to strengthening the country's capability in the development of space technology applications as well as building up space infrastructure through the development and launching of satellites.

Strengthening the Technological Capability of the SMEs

12.59 In the context of the rapidly growing technology sector, SMEs will gain from new businesses arising from spin-offs, outsourcing and joint-ventures. There will be opportunities in providing specialized services, manufacturing of parts and components as well as creating multimedia contents. Agencies such as SIRIM Berhad, MIMOS Berhad and Technology Park Malaysia (TPM) as well as universities will accelerate their technical assistance programme to strengthen the technological capability of the SMEs. The incubator facilities at various institutions will assist in the development of a new breed of technology-based SMEs for listing on the Malaysian Exchange of Securities Dealing and Automated Quotation (MESDAQ).

IV. ALLOCATION

12.60 The Federal Government development allocation and expenditure for the period 1996-2000 and allocation for the period 2001-2005, are as shown in *Table 12-5*. The Government will increase the funding for R&D and

TABLE 12-5

DEVELOPMENT ALLOCATION FOR SCIENCE AND TECHNOLOGY, 1996-2005
(RM million)

Programme	*7MP*		*8MP*
	Allocation	*Expenditure*	*Allocation*
Intensification of Research in Priority Areas (IRPA)	755.0	718.1	1,000.0
Malaysia-MIT Biotechnology Partnership Programme	35.0	33.3	-
Technology Development for SMIs	58.0	41.2	30.0
Technology Acquisition Fund (TAF)	118.0	118.0	250.0
Commercialization of Technology	208.0	203.9	610.0
Industrial Research and Development Grant Scheme (IGS)	50.0	45.9	200.0
MSC Research and Development Grant Scheme (MGS)	65.0	65.0	200.0
Demonstrator Applications Grant Scheme (DAGS)	30.0	30.0	100.0
Commercialization of Research and Development Fund (CRDF)	63.0	63.0	110.0
S&T Infrastructure and Development	2,413.3	1,496.7	2,818.9
Total	**3,587.3**	**2,611.2**	**4,708.9**

commercialization of technology to RM1.6 billion, while RM2.8 billion will be provided for related infrastructure facilities and services. To promote S&T awareness, an allocation of RM14.7 million will be provided.

V. CONCLUSION

12.61 During the Seventh Plan, the implementation of the various programmes contributed towards broadening and improving the S&T base. During the Eighth Plan, the Government will continue to intensify efforts towards innovation- and technology-led development to meet the requirements of a knowledge-based economy. To complement the efforts of the Government, the private sector will need to keep pace with the technology advancements in the global environment as well as expand their capacity in R&D.