

Chapter 19

Science and Technology

MOBILIZING KNOWLEDGE, AND SCIENCE AND TECHNOLOGY FOR PRODUCTIVITY, ECONOMIC GROWTH AND JOB CREATION

I. SITUATIONER

Research today is the source of new jobs tomorrow, not simply the source of ideas for others. Imbibing new knowledge and bringing the products of that knowledge to market are keys to success in the knowledge century. But breakthroughs do not happen by chance; they happen through sustained and dedicated effort. Science and technology (S&T) are important for productivity, economic growth and job creation.

Moreover, knowledge is increasingly recognized worldwide as the driver of economic growth and social wellbeing. Over forty percent of the world's economic output involves knowledge and its management. Thus, the "knowledge-based" economy has emerged as one that is directly based on the production, distribution and use of knowledge and information as reflected by growing high-technology investments, high-technology industries, demand for more highly-skilled labor and associated productivity gains. In a knowledge economy, investments in research and development (R&D), education and training and new managerial work structures have become important factors.

Thus, current efforts have placed S&T at the forefront of the national agenda/consciousness as it is a key driver of economic growth. S&T policies shall inform economic policies just as much as economic policies need to inform and influence S&T policies.

Following are the key challenges in S&T and in the mobilization of knowledge for greater productivity and economic growth:

A. Need to make S&T policies coherent with national development goals

The thrust of S&T policies has significantly changed over the last two decades. Globalization and trade liberalization have fundamentally transformed the economic environment in which both government and private firms operate, thus, rendering some national S&T policy instruments less effective. While S&T policies traditionally point to 'market failures' as their rationale, they are now being redesigned and refocused to instead address 'systemic failures'.

Market failures occur when private firms and individuals do not adequately invest in S&T development, particularly in R&D, as they do not expect any worthwhile financial returns considering its long gestation period, high cost and high risks. Hence, governments intervene to produce public goods and services (such as actual conduct of R&D), mitigate externalities, correct inefficient market structures, break down barriers to entry, and address imperfect markets for information.

On the other hand, systemic failures arise from the lack of coherence among the networks of institutions, resources, interactions and relationships, political mechanisms and instruments, and scientific and technological activities that define, promote, articulate and encourage technological innovation and diffusion (generation, importation, adaptation and dissemination of technologies) process. To address ‘systemic failures’, governments pay closer attention to fiscal, financial, regulatory and institutional reforms that seek to improve networking among the actors and institutions in the national innovation system; promote innovative behavior, particularly among private business firms in terms of building their ability to identify, absorb and use technologies and information; support R&D as a national strategy in expanding the stock of knowledge; make the S&T enterprise more efficient and effective; and improve the functioning of the national innovation system as a whole.

New conditions call for new S&T policies. The key policy challenge is to boost productivity, economic growth and job creation through increased knowledge-intensive economic activities while maintaining social cohesion. Shaping up the ‘Philippine National Innovation System’ will require S&T policies that are more focused, integrated to and coherent with other socioeconomic policies. To achieve this, a clear and better understanding of the flows of knowledge and technology among people, enterprises and institutions has to be attained. Mismatches within the system both among institutions and government policies that serve as barriers to innovation have to be identified.

B. Weak knowledge base

The sociocultural, political and economic environment sets the stage for the formulation of appropriate economic, education, S&T, labor, trade and industry policies that collectively affect the rate with which the country’s knowledge base is formed. This, however, is also conditioned by the interaction and collaboration between the academe and S&T community as producers of knowledge, and the industry as users of knowledge. The outcomes of their relationships influence the capacity of the economy to produce products and services for changing market needs.

The following factors indicate the weaknesses of the country’s knowledge base:

1. Lack of Critical Mass of R&D Human Resources

The country lacks a critical mass of R&D workers as it has only 6,803 scientists and engineers engaged in R&D in 2002, a significant decrease of 39.3 percent from the 1996 level. The decline occurred among government, public higher education and private nonprofit institutions. Brain drain contributed to the country’s declining number of S&T practitioners. Since knowledge and technologies are mostly embodied in human resources, this points to the urgency of the need to accelerate the development of R&D human resource in the country.

2. Underinvestment in R&D

The country’s expenditures in R&D amounted to PhP4.5 billion in 2002, only 0.11 percent of the gross domestic product (GDP) and far too less than the standard 1 percent of GDP recommended by the United Nations Educational Scientific and Cultural Organization (UNESCO) for developing countries. While the private sector (private business, private nonprofit and private higher education institutions) already contributes the bigger portion of the R&D investments (64% of the PhP4.5 billion total R&D expenditures in 2002), there is a need to promote greater R&D investments from both private and public sectors.

3. Low Number of Scientific Publications and Patents

The low number of R&D personnel in the country would naturally result in lower scientific outputs. To provide a glimpse of the poor state of S&T in the country vis-a-vis other countries, a comparison of scientific articles published by origin of author in 1999 placed the Philippines at 29th place among the 30 countries included in the Institute for Management Development survey. The Philippines had 164 published scientific articles, 22 more than last placer Indonesia. By comparison, Malaysia had 416, Thailand had 470, and Taiwan had 4,655 scientific articles to their name. The United States (US) at 1st place had 163,526 published articles.

The average number of patents granted to residents of the Philippines from 1998 to 2000 stood at six, placing the country at 28th, out of 30 countries. Malaysia at 27th place had an average of 28 patents for the same three-year period; 22nd place Thailand had 65 while 3rd place Korea had 34,052 patents. The low number of patents granted is attributed to the lack of government's capital support for patenting as well as the lack of government and public support in the promotion of inventions.

C. Need to improve the competitiveness of the country's knowledge and S&T workers

The Philippines was ranked 3rd out of 49 nations in producing knowledge jobs in 2001, up from 8th in 2000, according to the United States -based META Group's Global Technology Index (GTI). The GTI is the successor of the Global New E-Economy Index (GNEI), a cyber atlas that represents an important measure of the economic dynamism and strength, as well as the technological capabilities and potential of each country. However, this is still lower than the country's 1st place ranking in the knowledge jobs category in 1999, which included ranking criteria on senior management, availability of IT skills, and qualified engineers.

Table 19-1 Comparison Chart for GTI Category Rankings

	2001 results	2000 results	1999 results
Knowledge Jobs	3	8	1
Globalization	44	41	35
Economic Dynamism and Competition	36	39	34
Transformation to a Digital Economy	39	35	32
Technological Innovation Capacity	45	38	38
Overall	30	32	26

Source: META Group

The decline of the Philippines from 35th to 39th in the transformation of the country's digital economy in 2001 was attributed mainly to the decline of the number of computers per capita, weak deployment of cellular access and small population of internet users. Meanwhile, the significant drop, from 38th place to 45th, in the technological innovation capacity category was due to the decrease in the number of patents issued. The total R&D expenditure also decreased, adding to the overall decline in this category. While the decline in the globalization category accounts for the decreased export of commercial services and direct investment flows abroad.

The greater challenge for the continuous development of the country's human capital base and productivity is to raise the level of skills of knowledge, and S&T workers. The capability of individuals to learn and apply new skills is necessary for the absorption and use of new technologies. This stresses the importance of building adequate capacity throughout the society to assess, absorb, and use knowledge/technology/best practices, and the need to address educational imbalances to meet the demands of a knowledge-based economy. The biggest challenge is the inadequate workforce amid the rising unemployment reality.

Hence, there is an immediate need to develop, nurture and attract talents, as well as to strengthen human capital investment. On the demand side, there is a need to clearly define the skills needed by the industry while on the supply side, an accurate and up-to-date knowledge that matches the demand requirements. Moreover, the supply of talented and skilled people should be scalable and sustainable over time.

To further facilitate the diffusion of knowledge, a stronger tie-up between industry and academe is needed for effective transfer of appropriate technology and advanced skills needed by the industry. A functional tie-up can immensely improve the relevance of the mission/vision statements of the higher educational institutions.

D. Poor mechanism for knowledge retrieval/exchange/dissemination

Access to knowledge and technology vital to the development of rural and remote areas in the country is still inadequate or nonexistent in many regions of the country. Hence, there is a need to accelerate the establishment of more community e-centers (CECs) which aims to provide universal access to ICT services, link communities, facilitate trade and commerce, and empower rural communities socially, economically and politically. Private sector participation needs to be tapped to contribute to this endeavor.

Knowledge needs to be disseminated to improve productivity across a wide spectrum of sectors as possible. The dissemination of knowledge is especially important to the poor because poverty is linked to low productivity. Knowledge dissemination and interchange through multimedia promotions, advocacy, training, and community discussions/meetings needs to be pursued especially in unserved and underserved communities.

E. Need to leverage knowledge for greater productivity and global competitiveness

Knowledge needs to be identified and appropriately packaged to target those who could make the most effective use of knowledge productivity-enhancing technologies. The challenge of intensifying content and creating knowledge is to organize knowledge networks to document and package best practices with the help of mass media, business, various church groups, academic institutions, professional organizations, LGUs, and civil society for the use of farmers, fisherfolks, ordinary office and factory workers.

Consequently, knowledge creation and interchange through content development, promotions, advocacy, training, and community discussions need to be encouraged and carried out, especially in the unserved and underserved communities. Involving rural communities in the development and adaptation of "content" suitable to the needs of the local populace, in a language and layout, which

they can comprehend, appreciate and eventually use, is a major challenge. Correspondingly, the involvement of media, academe, as well as business and civic sectors of society is critical in knowledge creation, packaging and mobilization.

F. Lack of mechanism/programs to promote and encourage entrepreneurship

To produce more quality entrepreneurs, an enabling environment that would foster entrepreneurial skills, competency and capacity must be encouraged. To enable micro, small and medium enterprises (MSMEs) to a formal, viable, growing businesses, there is a need for start-up incubation centers that would provide technology, in-house credit, legal, and marketing assistance to locators; promotion of microfinance for entrepreneurs, streamlined processes for loan application; provision of one-stop shops for marketing support; and provision of training to develop/enhance entrepreneurial skills. In providing a stimulating environment for entrepreneurs, there is a clear need to document and feature entrepreneurial success stories in various mass media to encourage others.

To complement the lending programs available to MSMEs, the Development Bank of the Philippines (DBP), through its Industrial Guarantee Loan Fund (IGLF) program, has already set aside PhP500 million as revolving fund for state colleges and universities or SUC-income generating projects of state universities and colleges (SUCs) and is also exploring the possibility of allocating a certain amount from its fund for the purpose. The IGLF aims to encourage the establishment and expansion of SMEs engaged in commercial manufacturing and manufacturing-related service providers in the Philippines.

The Land Bank of the Philippines (LBP), on the other hand, has existing tie-ups with eight SUC projects through its Technology Promotion Center Program, a credit program that provides credit to farmers. It also taps available technologies in SUCs to be used by the farmers.

II. GOALS, STRATEGIES AND ACTION PLANS

In a knowledge-based economy, the generation and exploitation of knowledge play the predominant role in the creation of wealth. The use of information to create value-adding knowledge will be the key to productivity enhancement and competitiveness. Knowledge has an enormous potential to further enhance the country's competitive edge and empower people to increase their productivity, which is critical in accelerating growth in agriculture, industry and services. Technical progress and the pursuit thereof, shall be institutionalized and sustained, which can lead to the sustained increase in incomes.

Two key sets of technologies have potential benefits to the poor. These are agricultural technologies, from green revolution up to modern biotechnology; and ICT. The challenge is to widely distribute modern agricultural technologies to rural farming population to extend the benefits of affordable nutrition to the poorer Filipinos. ICT enables the collection, storage and access to explicit knowledge but much remains tacit, or embodied in individuals and institutions. The real benefits of ICT lie not in the provision of technology per se, but rather in improving communication and information exchange through networks of people. ICT will be harnessed as a powerful enabler of capacity development. It will therefore be targeted directly towards specific development goals like ensuring basic education for all and lifelong learning, among others.

As local communities become part of global networks, they transcend cultural barriers and challenge policy, legal and regulatory structures within and between nations. At the same time, a knowledge-rich world is striking down many of the traditional rules that governed organizations, with some parallels for countries as well. For organizations to survive and prosper, they need to adapt and learn, sustaining transformational change through a combination of individual and institutional learning. This new knowledge guides the use of resources, the fostering of teambuilding, the management of complex matrix relationships (Khadar et al., 2003).

The policy imperatives over the medium term shall give attention to knowledge creation dissemination and technology transfer. While knowledge diffusion and technology access remains important, making better and smarter use of information and knowledge is the key challenge. Likewise, addressing the information and communication needs of the poor and creating a knowledge-rich society however, are also essential parts of addressing poverty.

To fully realize the benefits of knowledge/information sharing, priority strategies shall be geared to enhance the structures that would efficiently and effectively process and distribute knowledge and technology in different functional areas across sectors. Projects and programs shall be effectively prioritized to support the identified priority strategies and activities.

A. Adopt S&T policies focused on making the Philippine National Innovation System work

The ability of economic and social actors to generate, absorb new knowledge and translate it to products and processes and job opportunities is fundamental to the dynamic functioning of innovation systems. Product market reforms such as the proposed competition policy (Part I, Chapter 1) shall enable more rapid diffusion of technology and information, and strengthen incentives for firms to innovate and adapt goods and services to changing consumer needs. Financial market reforms shall promote new technology-based entrepreneurial initiatives. The barriers to entrepreneurial technology-based projects and obstacles to their transformation into business start-ups shall be addressed while measures to spur greater management and innovation capabilities within firms, raising their potential for growth and investment in technology and skills shall be put in place. Regulatory barriers to entry shall be reduced, and private venture capital industry shall be promoted. Programs to leverage private investment and direct financial support concentrated on early stages of innovative ventures (seed capital or preinvestment appraisal) shall be established. Disincentives to “technological entrepreneurship,” particularly regulations discouraging spin-offs from large firms and universities shall be removed.

In the area of education (*Chapter 18: Education*), priority shall be given to: (a) the elimination of illiteracy; (b) increased investment in higher education, especially engineering and science; (c) the expansion and quality upgrading of technical and vocational education; and (d) the establishment of the equivalency program facilitating mobility of learners and workers between vocational and technical and academic studies. These will contribute to further innovation, facilitate the use of new technologies, and allow technical change to translate into more jobs.

In attracting foreign investments, more attention shall be given to acquiring know-how from external sources, such as supplier-customer linkages, licensing, alliances, partnership arrangements and networks for joint R&D, production and distribution. Exporting shall be harnessed as an effective means of acquiring technological capabilities. The international community shall be tapped in creating mechanisms to support the flow of technology and in assisting the country to become more attractive both to foreign investors and to potential trade and technology partners.

Greater support for research in the public sector, specifically in the areas of agriculture, health, engineering and social sciences, shall be provided to ensure that local interests and needs are acted upon. The further development of indigenous knowledge systems will be encouraged and capacities for the assimilation of transferred technologies.

Considering the limited budget of the government, the support of private investments in S&T and R&D shall be encouraged by creating links between knowledge generation and business development and design policies and incentives that promote the use of intellectual capital in economic transformation through entrepreneurial activities. Resources shall be channeled towards pressing development problems that are currently underfunded by tapping donor support for research, which can be funded through international cooperative project focusing on local or under-represented research activities, among others. For more efficient utilization of scarce resources as well as synchronized and focused R&D efforts, recentralization of S&T to the extent appropriate and feasible shall be considered.

As the coverage of patent and copyright protection expands to include life forms and data banks, laws on the protection of intellectual property rights in line with the Agreement on Trade-related Intellectual Property Rights shall continuously be reviewed to ensure that they protect inventions, as well as promote the transfer and development of technology and take into account the social impact of technological change. Government shall provide full support to local inventors by managing the intellectual property rights and balancing the need to protect the rights of inventors and technological development.

The importance of patents and other intellectual property rights, as well as their processing shall be encouraged. If possible, the processing of patent applications, including legal support, shall be free-of-charge including legal support. Labeling of Filipino made products shall also be promoted, as well as the conduct of massive information campaign to the masses on the significance of locally made products. A comprehensive and updated database of new products invented by our scientists shall be made available to the consumers/public.

A comprehensive technology transfer policy shall be designed and enacted to feature the following policies on: (a) sharing royalties that is more attractive to government-supported innovators; (b) a policy encouraging technology-based entrepreneurship among scientists and researchers; and (c) allowing scientists and researchers in government to work in the private sector without violating the code of ethics for government workers. The contribution of the academe and private sector in the publication of scientific articles shall be encouraged and supported thru recognition and other incentives.

The institutional arrangements for S&T policy formulation like the S&T Coordinating Council (STCC) under the DOST shall be strengthened. Moreover, the capacity to assess and review the country's national innovation system, and to evaluate the impact of national policies on the innovation processes shall purposively be developed.

B. Improve the competitiveness of the country's knowledge and S&T workers

Knowledge creation shall entail the improvement of the educational system and the system's ability to meet industry requirements. The challenge of a knowledge-based society, which is reshaping

the world with rapid change and growing uncertainty, is the creation and maintenance of qualified workforce with creativity and flexibility. Hence, training and capacity building shall be provided to its direct beneficiaries to ensure local support and program sustainability. Strategies to continuously create and maintain a highly skilled workforce shall be pursued to develop the competitiveness of the country's knowledge and S&T workers and remain competitive in the globalized market. Efforts shall be directed towards the following:

1. Provide greater access for the upgrading of job skills

The rapid obsolescence of knowledge and technology requires continuing education and training for any workforce to remain competitive. Lifelong learning is essential to meet the demands of the changing labor market, as well as individual expectations to meet the varied needs of civil and social aspects of life. At a holistic and systematic point of view, continuing education and training shall be a shared responsibility among the academe, education and training institutions, as well as the trade unions.

The dissemination of information on where the jobs are and the presence of the necessary support services such as training programs and scholarships would increase chances of finding a job. Workshops, seminars, presentations, as well as informal refresher sessions would arm them on the specific skills currently demanded by the labor market. People are able to upgrade their skills and have a better chance of being employed. A concrete example of this is the tie-up of the industry and academe on skills training and development. Through this, the gap on skills requirement of the industry and the actual capability developed in the academe can be addressed.

The following activities shall be undertaken:

- a. Empower workers (e.g., OFWs and their relatives) with new technologies (e.g., capacity enhancement, alternative livelihood opportunities) through training programs (e.g., trainor's training, specialist training, computer and entrepreneurial skills);
 - b. Enhance training regulations to add quality and productivity and entrepreneurship skills to its current tool and core competencies;
 - c. Intensify the availability and quality of skills-specific training programs (e.g., call center services, data and medical transcription, software development, animation, engineering and product design, e-financial shared services);
 - d. Strengthen industry-academe partnership on skills training and development (*Chapter 18: Education*);
 - e. Develop critical mass of scientists and R&D personnel;
 - f. Encourage and provide scholarships and R&D grants to support young and budding researchers; and
 - g. Award and recognize the outstanding contributions and achievements of Filipino scientists and researchers.
- 2. Set and implement quality standards, accreditation and certification systems with local and international recognition** focused on executive and managerial manpower, knowledge, and S&T workers as well as schools and training centers (e.g. quality assurance framework for ICT education).

Maintaining quality workforce that is at par with global standards can be achieved through certification programs. Certification leverage also places the workforce into a better position to meet the demands of the changing global manpower market.

3. *Promote the use of ICT in all sectors of the society, as a tool for people empowerment*

The establishment of CECs shall serve as public access points for distance learning, health, training, livelihood, entrepreneurship, market, communication, e-government, and other social programs. The CECs shall be tapped by the *Tulay Program*, as access facilities where OFWs can communicate with their families using e-mail, video conferencing, and instant massaging. These CECs shall be managed by local communities.

Meanwhile, ICT shall be used as tool for teaching and diffusing technologies in all levels of education. The boundaries between school, home and working life are diminishing. These require new methods in teaching (e.g., use of ICT resources) in which collaboration and sharing are essential in providing students with learning skills in net-based environments. Changing learning environments requires combining educational expertise and collaborative methods in teaching. In this regard, the following activities shall be undertaken: promote e-learning and information literacy; and establish e-learning competency centers.

4. *Deal with brain drain by turning push factors into pull factors.*

Return migration and reverse flows of income will be stimulated by encouraging remittances and investments that will be channeled toward development efforts. Diaspora and networks of Filipino S&T workers abroad shall increasingly be tapped as an important medium for knowledge sharing. The capacity to monitor, evaluate and respond to the emigration of the Filipino highly skilled workers shall be enhanced.

The *Balik-Scientist Program* of the DOST shall be improved and expanded with greater private sector participation.

The implementation of the Magna Carta for Scientists and Personnel (RA 8439) shall be strengthened, thru the provision of adequate financial support to implement the provisions of the law.

C. *Accelerate knowledge creation and transfer to upgrade technologies and increase productivity*

A favorable policy environment to intensify knowledge creation will be pursued by allocating a bigger percentage of the agency budgets for R&D and field extension work and providing funds for knowledge creation and management activities within the organization. In line with this, partnerships or networking arrangements with the private sector, academic and international institutions (e.g., IRRI, UNDP) shall be promoted and strengthened. The development of content and applications shall be encouraged to maximize the use of the country's existing ICT infrastructure for knowledge creation and dissemination. Moreover, upgrading of existing and establishing new R&D laboratories, design and testing facilities and other research, development and extension centers and the setting up of technology parks shall be pursued to ensure access to research facilities, simplify technology transfer operations and to allow incubation of spin-off enterprises.

Efforts to mobilize knowledge will be directed to disseminating information/knowledge to the rural and urban poor through the development of a communication policy framework to: encourage knowledge dissemination activities; promote partnerships between mass media and knowledge institutions; strengthen knowledge institutions, extension workers and civic organizations; and leverage existing government communications infrastructure for knowledge sharing/dissemination. The establishment and promotion of the use of extension centers, CECs, *Gabay sa Mamamayan Action Centers* (GMACs), Farmers' Information and Technology Services (FITS) centers, KALAHI Farmers Centers (KFCs)] and the wider use of knowledge dissemination models shall be pursued. Efforts shall also be made to strengthen and maximize the use of the PCARRD technology extension model and other farm/community extension models, and consolidate them with other similar extension models of other agencies and bureaus, including the DAR *Bayanihan* Rural Development Centers and DA's Agricultural Training Institute, among others.

Local industries and the entire bureaucracy shall be supported in the conduct of seminars, fora, conventions; documentation, packaging and distribution of best practices; institutionalization of rewards and recognition; and establishment of knowledge-based systems and mechanisms.

Research, development and extension outputs shall be promoted to local and global markets through the development and implementation of a marketing plan/mechanism and strengthening resource generation and mobilization. A national level assessment mechanism for knowledge creation, dissemination and use shall be institutionalized.

A critical mass of library and information resources shall be made available to all Filipinos in a convenient, affordable and efficient way through sustainable and collaborative schemes like the Philippine e-Library offering both free and fee-based products and services.

D. Promote technology-based entrepreneurship

Increasing people's productivity and enhancing global competitiveness would attract more investments and will develop economically viable industries. Domestic and foreign investments and entrepreneurship are imperative to the creation of more jobs and consequently to the productivity of the country.

To provide technology, marketing and other business development support to new entrepreneurs and continue product development as part of technology support to MSMEs, the following activities shall be undertaken: (a) continue the implementation of Small Enterprises Technology Upgrading Program and the Technology Incubation for Commercialization Program (TECHNICOM); (b) provide product research, development and design services (design and technical assistance); and (c) conduct design awareness activities such as product development seminars, trends, briefings. To maintain existing and develop more competitive export products and services and diversify market, quality testing and metrology-related services and orientation of producers on international product standards and conventions shall be provided.

To improve productivity and encourage the development of new products through R&D, appropriate technologies and best practices (e.g. clean production, hazard analysis and critical control point, good manufacturing practice, etc.) shall be adopted and diffused. Development of biotech products for commercial production and export shall be pushed. Efforts will be made for the adoption of innovation and technology transfer policy that is more conducive to scientists and innovators. Contract researches with the private sector shall be pursued to increase funding for R&D. The

allocation of resources for R&D among government agencies shall be rationalized. Cost sharing between the government and the private sector in the conduct of R&D shall be encouraged.

Since access to funds has always been a limitation, special credit programs will be provided to MSMEs for technology venture capital financing. To expedite available technologies in State to be used by farmers, extension workers, entrepreneurs and other intended beneficiaries, SUC demonstration projects and other income generating projects shall be pursued for LBP and DBP financing. Funds shall also be allocated to commercialize locally developed products not only for local but also for global consumption. Techno- and agri-based entrepreneurs shall also be organized to establish alliances and networks of entrepreneurs.

To enhance MSME's access to a wider range of available technologies, the government shall provide technology information and technology development services, such as patent search services for dissemination to MSMEs. MSMEs may access information on lapsed, expired or off patents in government websites and published materials. Technological information contained in patent documents shall be made available to MSMEs. MSMEs and local technology generators shall be assisted through the TECHNICOM program in: technology assessment and commercial prototype development; business plan/feasibility study preparation; intellectual property rights protection; technology valuation and licensing; semicommercial production assistance; and training and consultancy services.

The government, in consultation with LGUs and the local Fisheries and Aquatic Resource Management Councils shall extensively promote community-based and environment-friendly mariculture activities with mangroves and fish sanctuaries development. Mangrove-friendly aquaculture, seaweed farming and fish cage culture shall be promoted in various coastal communities based on the ecosystems' ecological capacity to further increase fish production and provide alternative livelihood for the fisherfolk while ensuring ecological integrity.