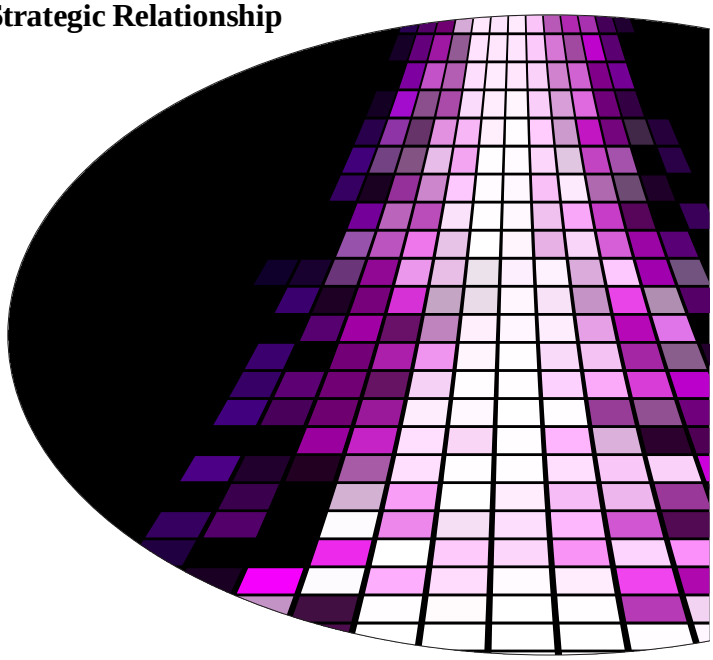
ISSN 0976 - 545X

Journal of Technology Management for Growing Economies

Volume 3 Number 1 April 2012

Government Initiatives for Developing Technologies in Public Research Institutesthrough Strategic Relationship with Industry

S. Rama Mohan



CHITKARA UNIVERSITY

DOI: 10.15415/jtmge.2012.31005

Government Initiatives for Developing Technologies in Public Research Institutes through Strategic Relationship with Industry

S. Rama Mohan
Indian Institute of Chemical Technology, Hyderabad

Abstract

The country that facilitates strategic relationships among research institutes and industries, through appropriate mechanisms, gains a competitive edge through faster technology development, transfer and commercialization. Successful technology development and transfer, needs early identification of potential technologies and assessment of their commercial potential. This study examines various models for technology selection and technology development available in the literature. Also, this communication presents various government initiatives that promote technology development, transfer and commercialization in Indian public research institutes. These initiatives try to bridge the gap between research institutes and industry and help research institutes to commercialize the technologies emanating from it. Important initiatives and their implementation were identified using an explorative study through a review of secondary sources and websites of concerned government departments.

Keywords: *Technology development, technology selection, public research institutes, government initiatives, institute/industry/government strategic partnerships*

INTRODUCTION

Promoting development of new technologies, its transfer and commercialization by making reforms in national research systems, can be observed worldwide today. Technology development is closely linked to scientific progress and connected with economic growth. New technology development needs generation and application of knowledge. For this, strategic relationship between industry and research institutes is very essential. The government has to play a key role to build a bridge between industry and public research institutes by promoting new mechanisms (Drejer and Jorgensen, 2005). It is essential to introduce appropriate policy measures to facilitate smooth and efficient technology transfer between public research institutes and industry as there is tremendous growth in scientific innovations. The country that facilitates strategic relationships among research institutes and industries through appropriate mechanisms, gains a competitive edge through faster technology development, transfer and commercialization (Marquesa et al., 2006).

A research institute is the primary performer of science progress. Usually, researcher's curiosity and inherent scientific worth drives technology development in public research institutes. Its research

Journal of Technology Management for Growing Economies
Vol. 3 No. 1
April 2012
pp. 79-94

concentrates on long term scientific breakthroughs. They do not focus much about market needs (Rama Mohan and Ramakrishna Rao, 2005). Industry seeks the research institutes for science that caters to the market needs. Industries seeks public research institutes to know and monitor the scientific progress. But scientific research has long term goals, whereas industry has short terms objectives (Betz, 1997). Therefore, government is facilitating programs that require strategic research partnerships between research institutes and industry to facilitate technological innovation.

For successful development of technologies and its transfer from public research institutes to industry, it is important that the scope, deliverables and timing of the research must be correct. Industry needs research to focus on technological need and at the technical barriers in an existing technology. Since industry needs technological innovation at the time of available commercial opportunity, it remains concerned about the timing of the research. Whereas, public research institutes do not worry too much about these factors, therefore, it is important to ensure that the proposed research facilitates successful technology transfer. Technology transfer from public research institutes to industry usually fails because of lack of early attention to these factors. Strategic research relationships between government, industry and research institutes is an effective strategy to create proper focus on scope, deliverables and timing of scientific research (Betz, 1997).

Few studies have studied the government policies that affect technology transfer from research institutes (Rasmussen, 2008). Successful technology development and transfer needs early identification of potential technologies and assessment of its commercial potential (Heslop et al., 2001). This study examines the various models for technology selection and technology development. Also, this paper presents various government initiatives that promote technology development, transfer and commercialization in Indian public research institutes. These initiatives try to bridge the gap between research institutes and industry and help research institutes in the development of technologies and further, in their commercialisation. Important initiatives and their implementations were identified using an explorative study through a review of secondary sources and websites, of concerned government departments.

Government of India provides financial assistance to the industries and research institutes for undertaking the work on development of new technologies. The financing gets provided in the form of grants, loan, and/or equity with an objective of strengthening research relationships of research institutes with industry. Government is encouraging the public

research institutes and the industries to device active research relationships so that they can provide financial support in the forms of grants-in-aid and concessional loans. It provides mechanisms that encourage the research institutes and industries for setting up of the demonstration plants, pilot plants, semi-commercial and commercial plants, all for the production of new technology based products (Upadhyay et al., 2010).

TECHNOLOGY SELECTION

This section presents the strategies that can be used for identifying probable technologies before embarking on actual development.

Research institutes have to identify the most probable future technological trajectories in the institute, such that they also overlap industrial interests. Institutes have to focus on the highly research intensive and profitable industries aiming for achieving market and technical leadership (Drejer and Jorgensen, 2005; Hameri, 1996). They have to analyze the present market situation and industry demand. Also, it would be helpful if they explore the possibility of the given technologies' adherence to global standards. Further they have to recognize the potential industrial applications of their nascent technologies (Hsu,2005).

Research institutes have to monitor the happenings in industries, operating in the institute's core R&D area. They have to understand the needs of clients and identify new technologies for the industries. They have to be aware of future technologies that are relevant to the industry. These are some of the measures that help research institutes in identifying potential technologies for development (Bruce, 2007). Before initiating new technology development, research institutes have to conduct extensive patent searches to ensure that the research results would cater to the industry requirements (Hsu, 2005).

Research institutes must gather information from market reports, international symposia, research publications, articles in science business magazines, industry proposals, websites, representative offices, experts at the institutes and consultants. Information gathered should be used in efficient technology selection. After that, research divisions which are involved in actual technology development, should select a few potential technologies for development. After that, before undertaking the actual development work, research institute must initiate a review with industry and academic experts in the field, by inviting them to participate in research planning. This would help in receiving criticism about and appraisal of the selected technologies to ensure that developing technologies cater to actual industry requirements. This will help in understanding the requirements

early in the R&D process leading to successful commercialization of the R&D efforts (Hsu, 2005).

The number of technologies could then be narrowed down. Then comparison among different technologies must be made in the areas like technology licensing payment terms and conditions, technology specifications and other important agreement clauses. Finally after all these deliberations, a single technology should be chosen for development such that it satisfies a customer need or future technological need (Hsu, 2005; Burnett et al., 1997; Greiner and Franza, 2003).

Research institutes can establish institute-industry cooperation committees involving large industries, in their field of interest. They must provide the industry various services like sending senior scientists to the industries in order to form networks between the institute and industries, circulation of research information of the institute, identification of needs of industries and establishment of R&D centers in collaboration with the industries (Wang, 2005; Upstill and Symington, 2002; Liu and Jiang, 2001).

Committees for specific areas of technology and for technology transfer could also be formed along with representatives from industry, to advise on the research needs of the industry. They could review and monitor research progress and serve as an information channel between institute and industry (Burnett et al., 1997).

TECHNOLOGY DEVELOPMENT

Technology development in collaboration with industry

Effective technology development and transfers require clear understanding about the technology and it must be timely and easily accessed. There is need for strategic research relationships between the research institute and supporting industry during development of technology. Through such collaborations, institute and industry work closely with each other and have the knowledge about the requirements of the technology. It reduces the gap between research objectives and technology requirements (Burnett et al., 1997; Greiner and Franza, 2003). If research institutes and industry work together towards developing the technology, then the developed technology will have good commercial potential (Rama Mohan and Ramakrishna Rao, 2003).

Special teams can be formed to monitor the technology development activity for effective development and transfer. The team should regularly interact with the industry regarding the project, to reduce communication gaps to a minimum, which is usually a major barrier in technology

development and transfer. This would ensure participation of all concerned at the early stages itself. As a second step, expertise and resources available at the industry must be examined. The level of participation expected from the industry in development of technology has to be decided. Possible risk areas have to be identified and necessary precautions have to be taken. Accordingly, provisions should be made in the agreement as well as the action plan.

The next step would be to quantify the objectives, scope of work and deliverables to be achieved at different stages of the project. It is preferable to define the targets to be achieved by different milestones and have clarity about the requirements. All these points must be finalized and mentioned in the agreement. Framing of the agreement is the most complex step as Intellectual Property Rights (IPR) and other issues needs lot of negotiations. Though the details of the technology to be developed is mentioned in the formal agreement with the client, there will always be something that is not mentioned in the agreement and parties understand and accept informally. Therefore, a defined research relationship is necessary where the concerned parties are clear about the objectives, scope and deliverables from each party. Any activity which could become part of the development of technology and transfer should be there in the agreement. Though development of technology and transfer would be carried out on the basis of an agreement, there would be several occasions when unexpected hurdles will come up, which could be managed by the trust and collaboration existing between the parties. After development of the technology, the final task would be the preparation of the detailed technology transfer document. It would include key milestones, specifications for milestone completion, resources required, training needed etc, (Manimala and Thomas, 2005).

Technology development through institute/government/industry strategic research relationships

Usually, scientific research has long term objectives and the researchers from research institutes are motivated by scientific fame. Commercial sector views technology in short term focusing on a particular commercial opportunity and the researchers from industry are motivated by the commercial success. Researchers from industry are knowledgeable about current technology, its problems, limits and barriers to technical progress. They focus on commercializing technologies and not on exploring ways to solve current technical

limitations. Also, they usually lack organizational climate to pursue long term scientific research. In contrast, researchers from research institutes pursue long term research programs and explore fundamentally new approaches that can provide alternatives to good technologies. They are generally less familiar about the details of existing technologies when compared to industrial researchers (Betz, 1997). Therefore it is important for the government to facilitate mechanisms to provide effective linkages among industries and research institutes. Researchers from industry and research institutes can work together converting their differences into complementary strengths and balancing among market push technology and market pull technology, short-term and long-term research (Betz, 1997).

Research institutes, along with industry, through government mechanisms, could focus on next generation technologies. Through the mechanisms facilitated by the government, research institutes and industry should focus on targeted basic research i.e., basic research for improving the technologies through understanding the phenomena underlying technologies and ways to imrove these technologies. In this way, research could be planned for needs of the industry and a next generation technology could be envisioned. Next generation technology is a technology that is a major advance over the domain of industry and which produces a significant competitive advantage (Betz, 1997). It requires dramatic improvement in performance.

Current technology has to be characterized as a system and identify technical barriers in it have to be identified. Further a description of the features that remain desirable but cannot be obtained, has to be generated. It also involves understanding the science behind the next generation technology system. It focuses on the barriers and how to overcome them. This concept requires understanding of current technology and planning of new research approaches. Therefore, the strengths of both the organizations can focus on new science for new technology development (Betz, 1997).

ESSENTIAL FACTORS FOR SUCCESSFUL TECHNOLOGY DEVELOPMENT

The strategic relationship between the research institute and industry during technology development is defined by the way of a research agreement. However, planning and finalizing it is very difficult. Many of the hindrances that come across in the development of technology can be avoided through a proper research agreement. Well drafted agreements provide clear direction

and provide details such as; objectives of the relationship, its structure, responsibilities of both partners, Intellectual Property Rights issues, dispute resolutions and termination conditions (Millson et al., 1996; Forrest and martin, 1992).

Continous communication helps in building up trust between the parties and eventually leads to successful relationship. There should be a common objective and it should be made clear without any ambiguity from the beginning of the relationship (Rogers et al., 1998). Mutual understanding of each parties' strengths and weaknesses is crucial for successful relationship. Relationship needs clearly defined objectives and operational milestones. Different strategic objectives, lack of mutual trust, ill-defined relationship structure, not adhering to the terms of the agreement, organizational differences are some of the reasons for failure of the partnerships (Slowinski et al., 1993; Blumenthal et al., 1986). Clear understanding of both the parties' responsibilities and tasks, clarity in terms of the agreement and adherence to it, defining deliverables accurately, periodic reporting and effective project monitoring are essential for relationships to be successful. Research institute and industry can define a plan of work to reduce the misunderstanding of project. The project profile must include: participants and their roles, understanding regarding the required resources, activity schedule, payment schedule, communication and reporting system, project control and confidentiality, expectations regarding publications, IPR and project extensions (Nilsson et al., 2009).

GOVERNMENT INSTRUMENTS TO SUPPORT TECHNOLOGY DEVELOPMENT IN INDIA

Government of India is offering several programs through its various ministries, for developing technologies through strengthening linkages between industry and research institutes. Such programs are discussed in this section.

Funding for technology development

Department of Biotechnology (DBT) under Ministry of Science and Technology, Government of India, offers grants for developing novel technologies in the area of human and animal healthcare, agriculture, environment, diagnostics using microbial processes, genetic engineering, computational analysis, computer simulation and other processes. Here, the focus is to provide need-based scientific leads to generate and transform research results into products utilizable by the industry and beneficial for the society. Also, it will fund for applying biotechnology for isolation and

characterization of novel bioactive agents, development of standardized and safe herbal formulations and genetic improvement of selected medicinal and aromatic plants. It also has another program where funding will be made for development of biosensors for detection of pollutants, treatment of industrial effluents, use of molecular markers for characterisation of biodiversity, etc (Department of Biotechnology, 2010).

Ministry of Environment and Forests is funding research in multi-disciplinary aspects for environmental and ecosystems protection, conservation and management in identified thrust areas under its Research & Development Programme. The objective of the scheme is to develop technologies which aids in better environmental management. It attempts to find solutions to the practical problems of resource management, conservation of natural resources and eco-regeneration of degraded areas. The different programs offered are environmental research programme (ERP), ecosystems research scheme (ERS), eastern and western ghats research program (E&WGRP), man and biosphere reserves and mangroves, coral reefs and wetlands and national natural resources management system (NNRMS) (Ministry of Environment and Forests, 2010).

Ministry of Earth Sciences (MES) will provide support for technology development in various fields of earth and atmospheric sciences like atmospheric research, coastal and marine ecosystem, climate change, disaster management, atmospheric technology, geoscience and ocean science and technology (Ministry of Earth Sciences, 2010).

Defence Research Development Organisation (DRDO) under Ministry of Defence, Government of India, provides funding for research institutes and industry, to develop critical technologies in various scientific fields. It provides funding under DRDO grants-in-aid scheme which is offered to various research institutes. It has constituted four research boards to provide grants-in-aid, to develop defence-related futuristic frontline technologies. These have application in the new world class systems to be developed by DRDO. The Life Sciences & Research Board (LSRB) provides funding in life sciences in areas such as biological and biomedical sciences, psychology and physiology, bio-engineering, specialized high altitude agriculture, food science & technology. The Naval Research Board (NRB) encourages researchers to develop marine technologies to strengthen and deepen the knowledge-base related to the naval environment. It focuses on innovative research work in marine bioactive resources, environmental hazards and operations. It also funds in the areas like composite materials. The Armament Research Board (ARMREB) funds projects in the fields of high energy materials, sensors, ballistics and other armament related fields (Defence Research and Development Organisation, 2010).

Funding for technology development in specific sectors

Department of Scientific and Industrial Research (DSIR) under Ministry of Science and Technology, Government of India, has proposed a program called "Technology Development & Utilization Programme for Women (TDUPW)" in order to meet the specific requirements of women and to enhance their contribution in technology development. The objectives of the proposed program are to promote the adoption of new technologies by women, to promote technological upgradation run by women entrepreneurs and to design and develop new technologies beneficial to women. Assistance in the program is by way of partial or full financial support and technical guidance. Funding gets provided to meet expenditure on manpower, consumables, travel within the country and other miscellaneous expenditure and the department does not offer support for basic infrastructure and buildings (Department of Scientific and Industrial Research, 2010).

Department of Science and Technology (DST) has been established with an objective of promoting new areas of science and technology under Ministry of Science and Technology, Government of India. It runs a program called 'Water Technology Initiative' which aims to promote R&D activities for developing technologies for providing safe drinking water at affordable cost and in adequate quantity. The focus is to develop new technologies that tackle the problem of water contamination and water scarcity. The program encourages research work to be carried by research institutes in association with industry and Non Government Organisations. It also encourages public-private-partnership in development of the technologies (Department of Science and Technology, 2010).

Department of Science and Technology (DST) also offers a program on drug development for promoting research in drugs and pharmaceuticals sector with an objective to strengthen the linkages between research institutes and pharmaceutical industries and to develop new drug technologies. It supports proposals that get initiated by industry and research institutes and offer soft loan for research and development to drug industry. It supports research in all systems of medicines. Usually, the research cost gets shared by research institutes and industry in a ratio is 50:50. If the research is carried out by industry, then it is funded fully by industry and the research institute's share is supported jointly by government and industry (Department of Science and Technology, 2010).

DST had launched a modest programme in nanoscience and technology in October 2001, called the Nano Science and Technology Initiative (NSTI). The successor of this programme was called 'Nano Mission'. It is a Mission-

Mode programme. It is an umbrella programme which aims at overall development of the field of research in the country and to develop some technologies for nation's development. In brief, the objectives of the program are, development of infrastructure for nano science and technology research and to catalyse the development of technology leading towards innovation in products and devices. It tries to involve the industry into nanotechnology research directly or through Public Private Partnership (PPP) ventures. The program promotes public private partnerships and joint institute-industry linked projects to focus the existing expertise of research institutes towards developing technologies that offer direct interest to industry. In many of these activities, the industry also has to invest financially, into the project. These activities help in leveraging the scientific knowledge base existing in research institutes along with the commercial vision of industry, to generate competitive technologies (Department of Science and Technology, 2010).

DBT has a mission programme that aims at perfecting technologies for establishing bio energy plantations for different agro-climatic zones. This is done with the involvement of local people and through economically viable production of ethanol using different raw material and efficient, high yielding strains of microorganisms. It also supports biodiesel production for oil and hydrocarbon, using alternate feed stock especially lignocellulosics wastes. It also utilises and improved transesterification process and works towards production of hydrogen from algae and bacteria (Department of Biotechnology, 2010).

FUNDING FOR TECHNOLOGY DEVELOPMENT AND DEMONSTRATION

DSIR offers a program called "Technology Development and Demonstration Program" with an objective of development and demonstration of new technologies that make industry competitive and also strengthen the linkages between industry and research institutes. The funding gets provided to any sector which offers industrially useful applications. The program aims at development of new technologies having good commercial potential and result in significant benefits in terms of high turnover, energy and material savings or recovery, export sales etc. DSIR the following; supports technology development related to a new or improved product resulting in prototype development and ending with demonstration, a new or improved process resulting in establishment of process know-how, development of process equipment and demonstration of yield in a pilot plant, absorption and up-gradation of imported technology, technologies for common use by cluster of industries and technologies for government's flagship and mission mode

projects. The program prefers to support the activities taken up after successful completion of a lab scale or bench scale work either by industry and/or by research institute. DSIR offers funds till completion of technology development and its demonstration at a pilot scale, before further commercialization of that technology. The proposed program does not support lab scale work at research institutes, bench scale work at industry, minor improvements in the technology and clinical trials (Department of Scientific and Industrial Research, 2010).

The program offers support for the development and demonstration of technologies at pilot plant level in the areas of chemicals, fertilizers and metallurgical industry. Industries, either on their own or jointly with research institutes, submit the proposals. The funding generally, gets limited upto fifty percent of the project cost. Industry is expected pay 1.3 times the amount received in the form of lump sum royalties for five years from the start of commercial production of the product. Intellectual Property Rights get jointly owned by the industry and the collaborating research institutes. The industry has the first right to utilize and commercialize the developed technology. The technology gets assigned to third party in case the industry does not commercialize the technology in a period of four years, after completion of the project, or if it does not exercise its option for commercializing the technology within one year of completion of the project. Revenues that accrue thereby get shared. The financial support provided under the program covers prototype development, cost of pilot plant, cost of process equipment development, test/evaluation of products and user trials. Industry has to bear the bulk of the project cost from its resources. The financial support is offered to primarily meet expenditures related to personnel, consultancy, patenting, running costs, testing, trials and certification (Department of Scientific and Industrial Research, 2010).

The objective of Technology Development Board (TDB) established by DST is to translate the fruits of research into commercial technologies. It encourages industry and other organizations to take up technology development projects. It aims at acceleration of technology development and its commercialization. It provides funding in the form of equity, soft loans, or grants. Mainly, it provides equity capital or loans to industry and financial assistance to research institutes (Department of Science and Technology, 2010**)**.

FUNDING FOR HIGH RISK PRE PROOF OF CONCEPT AND LATE STAGE DEVELOPMENT OF TECHNOLOGY IN BIOTECHNOLOGY

Department of Biotechnology initiated a program called The Small Business Innovation Research Initiative (SBIRI). This program aims at boosting

public-private-partnership in different sectors of biotechnology. It supports high-risk research and development projects in small and medium industries which are lead by innovators with science as their academic background. The program follows a unique process for generating ideas by bringing users and producers of technology together. It aims to increase commercialisation of technologies that emanate from public funded R&D particularly in the areas of healthcare, food and nutrition, agriculture and other sectors. It nurtures and mentors innovative technologies and emerging entrepreneurs. It further assists new industries to forge appropriate linkages with public funded research institutes. The program covers all areas in biotechnology related to health-care, agriculture, industrial processes and environmental, bio-medical devices and instruments (Department of Biotechnology, 2010).

The program will operates in two phases. The first phase is for establishment of pre-proof of concepts of innovation and the second phase is for product and process development. In both the phases, projects are implemented at the industry site. However, the actual project cost involves only capital investment and recurring costs. In phase I, government provides eighty percent of the grant if the actual project cost is upto twenty five lakh rupees. If the actual project cost is between twenty five lakh rupees and hundred lakh rupees, government provides half of the project cost as grant, subject to a minimum of twenty lakh rupees and a maximum of fifty lakh rupees. If the project cost is beyond hundred lakh rupees, government provides a grant of fifty lakh rupees and interest free loan upto fifty per cent of the amount. In Phase II, a soft loan upto ten crore rupees gets provided for a project, as per its requirement. The interest rate is one percent upto hundred lakh rupees and two percent beyond hundred lakh rupees. As many of the projects need technical support from public research institutes, their role is critical at this stage. The public research institute at this stage get R&D support from the government as grant (Department of Biotechnology, 2010).

FUNDING FOR ACCELERATING COMMERCIALIZATION OF ALREADY DEVELOPED TECHNOLOGIES IN BIOTECHNOLOGY

Department of Biotechnology has proposed & another program called Biotechnology Industry Partnership Programme (BIPP) which aims at the development of futuristic technologies, which have major economic potential. The program is meant for high risk technology development. No incremental development in technology gets supported under this program. The program funds for development of technologies in health, agriculture, energy/environment friendly manufacturing, for meeting the country's needs . This program, hence, promotes the development of technologies in bioenergy sector, agriculture, vaccines, biomedical devices, implants, drugs and biotherapeutic agents for

major infectious diseases, like HIV, tuberculosis, malaria, influenza, dengue, etc as well as for chronic diseases such as diabetes and stroke. It is envisaged that research relationships with public research institutes would be useful, so that the basic research leads can be translated to product development by the industry. This program hence, funds for developing high risk futuristic technology development with research relationships with industry. It does not support incremental developments. It only supports complete technology development leading to high value product commercialization like nanoscience applications in medicine / agriculture, bio-based energy related advanced biotechnologies, advanced biomaterials, stem cell biology, tissue engineering, system biology, computational biology, genomics, proteomics and metabolomics related technologies for futuristic diagnostics. (Department of Biotechnology, 2010).

The program also funds for evaluation and validation of already developed products of high national importance. This is done through research relationships with industry. To accelerate the commercialization of existing products, support for product evaluation and validation is needed. For example, biopharma products' clinical trials and agriculture products' field trials, are critical to take these product to the market. Grant-in-aid support upto hundred percent gets provided for phase-I, II and III clinical trials of biotechnology based research efforts, For example, and for limited and large scale field trials, in the case of agriculture products. The grant does not include any compensation / support for capital investment. The proposals for funding are submitted by industries, either society or in collaboration with public research institutes. (Department of Biotechnology, 2010).

FUNDING FOR TECHNOLOGY DEVELOPMENT IN RENEWABLE ENERGY

Ministry of New and Renewable Energy (MNRE) supports technology development in the area of renewable energy. It aims at technology development through close involvement with industry. It considers proposals that promise for commercialization in future. It covers areas such as rural energy, solar energy, energy from wastes, power generation through wind, biomass and small hydro. It encourages development of new technologies in fuel cells, hydrogen, ocean and geothermal energy. The projects are taken up by research institutes, individually or in collaboration with the industry. It is encouraged that projects get taken along with industry since it ensures that the industry is involved right from the conception stage. Funding for projects involving industry, is normally restricted to half of the project cost. However, for proposals from research institutes, funding could even be hundred percent, depending on project priority.

CONCLUSION

Technology development is closely linked to progress in scientific research. As technology development is connected with the generation and application of scientific research, there is a need for research relationships with industry and research institutes. The government has to promote and facilitate mechanisms to bridge the gap between research institutes and industry for accelerating new technology development. The country that encourages links among research institutes and industries, gains a competitive edge through faster diffusion of technology development and transfer. Therefore, government has to play a crucial role here.

Government has to facilitate programs that require strategic research relationships between research institutes and industry. For successful technology development and transfer of research from public research institutes to industry, it is important that the scope of work, deliverables and timing of the research are appropriate. Most of the times, the technology transfer from public research to industry in the past has failed because of the lack of early attention to these factors. Strategic research relationships between industry and research institutes that get facilitated by government, are an effective means to create a platform for scientific research for industrial use.

Successful technology development and transfer, needs early identification of potential technologies, along with an assessment of their commcercial potential. Government of India provides funding to the industries and research institutes for undertaking new generation technology development. The funding is provided in the form of grants, loan, and/or equity with an objective of strengthening the linkages of research institutes with industry. Government encourages the public funded research institutes and the private sector industries to enter into active research relationships at pilot stage, Semi-commercial stage and final-commercial stage. For this financial support is provided to the participating organizations.

ACKNOWLEDGEMENTS

The author thanks Director, IICT for his encouragement.

REFERENCES

Betz, F. (1997) Academic/Government/Industry Strategic Research Partnerships, *The Journal of Technology Transfer*, 22:3, pp. 9-16

Blumenthal,D., Gluck,M., Seashore Louis,K., Stoto,M.A. and Wise, D. (1986) University–industry research relationships in biotechnology: implications for the university, *Science*, 272, pp.1361.

Bruce, L.M. (2007) Research Institutes have become industry partners, Res. Tech. Mgt., 50:4, pp. 42.

Burnett, L.M., Massari, G.B. and LaScala, R.D. (1997) 'Transforming academic research findings into economically profitable technologies', *The Journal of Technology Transfer*, 22:3, pp. 17.

Department of Biotechnology(2010), (online) (cited August 2010). Available from <URL:http:/ /www.dbtindia.nic.in>

Defence Research and Development Organisation (2010), (online) (cited August 2010). Available from <URL:http://www.drdo.nic.in>

Drejer, I. and Jorgensen, B.H., (2005) The dynamic creation of knowledge: Analysing public–private collaborations, Technovation, 25:2, pp. 83.

Department of Science and Technology(2010)', (online) (cited August 2010). Available from <URL:http://www.dst.gov.in>

Department of Scientific and Industrial Research (2010)', (online) (cited August 2010). Available from <URL:http://www.dsir.gov.in>

Forrest, J.E. and Martin, M.J.C. (1992) Strategic alliances between large and small research intensive organisations experience in biotechnology industry, R&D Mgt, 22:1, pp. 34.

Greiner, M.A. and Franza, R.M. (2003) 'Barriers and bridges for successful environmental technology transfer', *The Journal of Technology Transfer*, 28:2, pp. 167.

Hameri, A.P. (1996) Technology transfer between basic research and industry. Technovation, 16:2, pp. 51.

Heslop, L.A., McGregor, E.M. and Griffith, M. (2001) 'Development of a Technology Readiness Assessment measure: The Cloveleaf Model of technology transfer', *The Journal of Technology Transfer*, 26:4, pp. 369.

Hsu, C.W. (2005) Formation of industrial innovation mechanisms through research institute,Technovation, 25:11, pp. 1317.

Liu,H., and Jiang, Y. (2001) Technology transfer from higher education institutions to industry in china: nature and implications. Technovation, 21:3, pp. 175.

Manimala, M.J. and Thomas, R. (2005) Development and transfer of advanced technology. TechMonitor, Nov-Dec, 17.

Marquesa, J.P.C., Carac, J.M.G. and Dizc, H. (2006) How can university–industry–government interactions change the innovation scenario in Portugal?—the case of the University of Coimbra, Technovation,26, pp. 534.

Ministry of Earth Sciences (2010)', (online) (cited August 2010). Available from <URL:http:// www.dod.nic.in>

Ministry of Environment and Forests (2010)', (online) (cited August 2010). Available from <URL:http://www.moef.nic.in>

Ministry of Non and Renewable Energy (2010)', (online) (cited August 2010). Available from <URL:http://www.mnre.gov.in>

Millson, R.R., Raj, S.P., Harlenum, D. (1996) Strategic partnering for developing new products, Res. Tech. Mgt, 39:3, pp. 41.

Nilsson, A.S., Rickne, A. and Bengtsson, L. (2009) 'Transfer of academic research: uncovering the grey zone', *The Journal of Technology Transfer*, 35:6, pp. 617-636.

Rama Mohan, S. and Ramakrishna Rao, A. (2003) 'Early identification of innovative and market acceptable technologies: A model for improving technology transfer capabilities in public research institutes', J. Sci. Ind. Res.,62, pp. 865.

Rama Mohan, S. and Ramakrishna Rao, A. (2005) Strategy for technology development in public R&D institutes by partnering with industry, Technovation, 25:12, pp. 1484.

Rasmussen, E. (2008) Government instruments to support the commercialization of university research: Lessons from Canada, Technovation, 28:8, pp. 506.

Rogers, E.M., Carayannis, E.G., Kurihara, K., and Allbritton, M.M. (1998) 'CRADAs as technology

transfer mechanisms', R&D Mgt, 28:2, pp. 79.
Slowinski, G., Farris,G.F. and Jones,D. (1993) 'Strategic partnering: process instead of event', Res. Tech. Mgt, 22 .
Upadhyay, V.K., Sikka, P., and Abrol, D.K. (2010) Technology dissemination programmes and extramural R&D support in India, *The Journal of Technology Transfer*, 35:6, pp. 680-690
Upstill, G. and Symington, D. (2002) 'Technology transfer and the creation of companies: CSIRO experience', R&D Mgt, 32:3, pp. 233.
Wang, B. (2005) 'Intellectual property management and value added strategy of the Industrial technology research institute', *J.Sci Ind Res.*, 10, pp. 376.

Dr. S Rama Mohan, is Senior Scientist Business Management Division, Indian Institute of Chemical Technology, Hyderabad. Email: rmohan_s@yahoo.com.

CHITKARA UNIVERSITY
Administrative Office
Saraswati Kendra, SCO 160-161
Sector-9-C, Madhya Marg, Chandigarh-160009, India.
Phone : +91.172.4090900, Mobile: +91.95011-05644
Email: journal@chitkarauniversity.edu.in
Website: http://journal.chitkara.edu.in

Printedby: Mr. Deepak Gupta, Savitar Press and published by Dr. Madhu Chitkara on behalf of Chitkara University, Saraswati Kendra, SCO 160-161, Sector-9-C, Madhya Marg, Chandigarh-160009 and printed at: Savitar Press, Plot No. 820, Phase-2, Chandigarh and published at Chandigarh.
Editor Dr. Vinnie Jauhari