Asia-Pacific
Economic Cooperation

Advancing Free Trade
for Asia-Pacific Prosperity

Knowledge Transfer Best Practices between APEC Economies

Lima, Peru | 13-15 June 2018

APEC Policy Partnership on Science, Technology and Innovation

January 2020

APEC Project: PPSTI 05 2016A

Prepared by CONCYTEC
Sub Directorate of Innovation and Technology Transfer - SDITT
National Council for Science, Technology and Technological Innovation
Chichon 867, San Isidro, Lima - Peru
Tel: 0051 13990030
Email: comunicacion@concytec.gob.pe

For
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace Singapore 119616
Tel: (65) 68919 600 Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

APEC#220-PP-01.1

Contributors

Speakers

Chile
Mr Alvaro Javier Ossa Daruich - Pontifical Catholic University of Chile

China
Mr Ma Leju - International Industries Study Team

Republic of Korea
Ms Soo Jeoung Sohn - Science and Technology Policy Institute

United States
Ms Mónica Alandete – Saez – PIPRA UC-Davis

Brasil
Ms Marli Elizabeth Ritter dos Santos - Pontifical Catholic University of Rio Grande do Sul

Malaysia
Ms Lai Oi Ming - University Putra Malaysia

Peru
Mr Pavel Corilloclla Terbullino – Independent Resercher

Delegates

Chile
Mr David Molina Concha - Economy Development Agency

Mr Etienne Choupay - Ministry of Economic, Development, and Tourism of Chile

China
Ms Zhu Junqiao - Zhejiang Normal University

Ye Jiaolong - Sichuan Institute of Nuclear

Malaysia
Ms Aini Suzana Ariffin - University Technology Malaysia

Mr Zakwan bin Azahari - Ministry of Agriculture & Agro-based Industry Malaysia

Mexico
Patricia Ocampo-Thomason - Center for Research and Assistance in Technology and Design of the State of Jalisco

América Padilla Viveros - Center for Research and Advanced Studies

The Philippines
Merlita Opeña - Philippines' Department of Science and Technology

Julius Caesar Sicat - Philippines' Department of Science and Technology

Thailand
Thininut Srichan - National Center for Genetic Engineering and Biotechnology

Moderators Team

Peru

Luis Julio Cesar de Stefano Beltran - Lead moderator

Miguel Sebastian Egoavil Ayala – Thematic sessions moderator

Alejandro Lengua Vega – Thematic sessions moderator

CONCYTEC - SDITT Team

Peru

Pedro Martín Bernal Pérez – Specialsit in Technology Transfer

Astrid Hassel Criales Johnson – Specialist in Innovation Projects

With the support of:

Karina Maldonado Carbajal

Leonardo Israel Gil Saravia

Gianpierre Raí Ponce Ruiz

CONACYT Team

Mexico

Gloria Lucía Valencia - Counselor for International Cooperation in Science, Technology and Innovation

Ariadna Hernandez De la Cruz - Head of Special Projects

Contents

Acronyms

APEC	Asia-Pacific Economic Cooperation
CONCYTEC	Council for Science, Technology and Technological Innovation
SDITT	Sub direction of innovation and technology transfer
CONACYT	Council for Science and Technology
PPSTI	Policy Partnership on Science, Technology and Innovation
BIOTEC	National Center for Genetic Engineering and Biotechnology
CIATEJ	Center For Research and Assistance in Technology and Design of The State of Jalisco
CINVESTAV	Center of Research and Advanced Studies
CORFO	Economic Development Agency
DOST-PCHRD	The Philippine Council for Health Research and Development, Department of Science and Technology
FONDEF	Fund for the Promotion of Scientific and Technological Development
FONDEY	Fund for Innovation Entrepreneurship of Yucatan
IADA	Integrated Agriculture Development Agency
IPOPHL	Intellectual Property Office of the Philippine
MARDI	Malaysian Agricultural Research and Development Institute
MCMC	Malaysian Communications & Multimedia Commission
MIDA	Malaysian Investment Development Authority
MOA	Ministry of Agriculture
MOSTI	Ministry of Science, Technology & Innovation
MTDC	Malaysian Technology Development Corporation
NSTDA	National Science and Technology Development Agency
OECD	Organisation for Economic Co-operation and Development
TAPI	Technology Application and Promotion Institute
TPM	Technology Park Malaysia
USFDA	US Food and Drug Administration
VIC	Value Innovation Centre

Acknowledgement

The authors and contributors of this report would like to thank the APEC PPSTI for supporting this project and this final draft. The report was elaborated thanks to the SDITT team, experts (speakers, delegates and the moderator team led by PhD Luis De Stefano) participating in the Workshop on Knowledge Transfer Best Practices Between APEC Economies, where they have had the opportunity to share their experiences in the technology transfer field and discuss its implications for public policy in APEC Economies.

Introduction

The APEC economies face specific challenges as a region and a way to address these in the best possible way is to increase the transfer of tangible and intellectual property, expertise, learning and skills between academia and the non-academic community between the APEC Economies. Knowledge Transfer (KT) is a term used to encompass a broad range of activities to support mutually beneficial collaborations between universities, businesses, public sector and society. KT provides a significant driving force for enhancing economic growth and societal wellbeing. For academics, KT can be a way of gaining new perspectives on possible directions and approaches for research. This two-way exchange element of KT is at the heart of successful and sustainable collaboration.

The workshop on Knowledge Transfer best practices between APEC Economies, held on the 13th – 15th June 2018 (Lima, Peru) aimed to create a platform for policy makers, scientists, academics and private sector representatives, to interact and share information and experiences in order to implement effective mechanisms to encourage Knowledge Transfer.

The project intends to foster the exchange of best practices among relevant stakeholders of the innovation ecosystems in APEC economies; targeting the knowledge transfer concept as a key factor to create value among the knowledge chain. As well to encourage collaboration of the implementation of policies related with Knowledge Transfer, through different experiences and models of APEC economies.

This project will consider as a general understanding and as starting point, that Knowledge Transfer is the movement of knowledge (from the scientific and technological production) for the public benefit; in other words, the use of research and technological outcomes to improve practices, in order to implement initiatives and to tackle specific problems.

The APEC economies have developed their own models to encourage the exploitation of the scientific and technological outcomes, with the aim to generate added-value in products and services to solve social needs and to create new market opportunities. Through the implementation of a Knowledge Transfer network, the project aims to share through the analysis of (selected) APEC economies' models, best practices, experiences and strategic information, that will result in the benefit of regional cooperation.

The Report: Policy recommendations to promote knowledge transfer, is a compilation of the main ideas discussed during the Workshop. The discussion focused on two general topics: 1) public policies to promote knowledge transfer and 2) mechanism to an effective knowledge transfer. Both included a sectorial approach in health, mining, and agriculture. The report aims to set out guidelines to be incorporated by policy makers and foster knowledge transfer in APEC region.

Additionally, the report is complementary with other efforts and projects supported by PPSTI – APEC.

I. Executive Summary

The Workshop Knowledge Best Practices Between APEC Economies took place between the 13th and 15th of June 2018 in the venue of Lima Convention Center (LCC), the largest multipurpose event space in the capital of Peru. The event had delegates from Chile, China, Korea, Malaysia, Mexico, The Philippines and Peru. Invited speakers came from Brazil, Korea, Malaysia, Chile and USA.

The Workshop was inaugurated by the President of CONCYTEC, Peru, Dr Fabiola León-Velarde and Mrs. Gloria Valencia, International Cooperation Adviser, CONACYT, Mexico, on the morning of the 13th. The plenaries were given by a superb group of speakers from Chile, China, Korea, Malaysia, Peru, and USA.

Mr Pavel Corilloclla, Doctoral Researcher in Science and Technology Policy Studies, Science Policy Research Unit, SPRU, University of Sussex, United Kingdom, gave the first plenary lecture on the morning of the first day of the Workshop with the title **Knowledge Exchange. Policies: Lessons and Challenges**, followed in the afternoon session by Dr Ma Leju, Senior expert, International Industries Study Team, DiDi with his lecture on **Policies to foster and promote the STI System in China** and Dr Alvaro Ossa, Head of Office Knowledge Transfer and Development, Pontificia Universidad Católica, PUC, Chile, who gave the last plenary lecture of the day, **Technology Transfer: from the research to the market**.

Dr Soo Jeoung Sohn, Associate Research Fellow in the Industrial Technology Strategy Research Division from the Science and Technology Policy Institute (STEPI), in Korea, gave the first plenary lecture of the second day on **Knowledge Transfer best practices between APEC economies** followed by Dr Ma Leju, who gave the first lecture of the afternoon plenary session on Policies and mechanisms to create synergy among academia, industry and government (Case studies) and Dr Mónica Alandete-Sáez, Director of Analysis & Education at PIPRA (Public Intellectual Property Resource for Agriculture based on the University of California, Davis), who gave the last lecture of the second day, **Public Intellectual Property Resource for Agriculture – UC Davis.**

The Thematic Sessions centered on Policies to promote knowledge transfer applied to agriculture, aquaculture, mining and health sector during the morning and afternoon of the first day. On the second day the sessions switched to Mechanisms to an effective knowledge transfer applied to agriculture, aquaculture, mining and health sector for the morning and afetrnoon sessions. These sessions were opened by technical lectures given by experts in each field followed by discussion of the delegates and public participants.

The Wrap Up Session on the 15th started with a plenary lecture given by Dr Lai Oi Ming, Member of the UPM´s Intellectual Property Evaluation Committee, University Putra Malaysia – Putra Science Park, who talked about **Knowledge Transfer and Innovation Science Park: A case study of University Putra Malaysia´s Innohub**.

Dr Henry Harrman, Director of Science, Technology and Innovation Policies and Programs of CONCYTEC opened the Summary of the Event part of the Workshop followed by a 2 hour-discussion section chaired by Dr Luis De Stefano, Professor, Universidad Peruana Cayetano Heredia.

II. Workshop

The APEC Workshop was held in Center Convention Center, Lima, Peru on 13 – 15 June 2018. It was attended by 11 delegates from six member economies (People's Republic of China; Malaysia; Mexico; The Philippines; Thailand and Peru). Additionaly, the Workshop had the participation of 9 experts from seven economies (People's Republic of China; Brazil; Chile; Korea; Malaysia; and The United States of America)

The workshop was structure in plenaries and thematic sessions. In these sessions, speakers, experts and delegates discussed about polices to promote knowledge transfer, as well as, issues regarding management. The last day, a wrap up session was given and discussed by participants. Other Peruvian experts with institutional support were invited to share specific successful cases in table disscusions with the delegates.

With the aim to have the maximum number of beneficiaries, the organizers invited the general public from the innovation ecosystems like: Economy bodies of science, technology and innovation, Funding agencies of science, technology and innovation, Relevant academic experts from public or private universities, Governmental entities (ministries, councils, others) and Technology transfer offices from the academic and the private sector.

The three days of the event were held in Lima Convention Center auditorium and its sessions rooms which are the most important infrastructure for events in Peru.

III. Opening ceremony:

The opening ceremony featured officials and representatives of The National Council for Science, Technology and Technological Innovation (Concytec) from Peru and The National Council for Science and Technology (Conacyt) from Mexico. Also, the ceremony included a representative of the Ministry of Foreign Affairs.

Dr Fabiola León-Velarde, President of Concytec, gave the keynote speech to the representatives and delegates from all economies attending the workshop. She started out her welcome address mentioning that the Workshop was the result of the institutional cooperation of Mexico and Peru Economies and the co-sponsoring of Canada, China, Chinese Taipei and the United States. She also underscored that technology transfer has been globally recognized as a force that drives and accelerates economic growth, competitiveness, the welfare of society and sustainable development. She went on to describe the Workshop structure and the main themes to unfold in the sessions. Finally, she declared the workshop officially inaugurated and wished the best for the development of the four thematic areas.

Mrs. Gloria Valencia, International Cooperation Adviser from Conacyt brought the perspective of the other co-organizer of the workshop and reminded us what Francis Gurry, Director General of WIPO, said last year: "… Intangible capital will increasingly determine the fate and fortune of firms in today's global value chains…" She concluded that the current challenges is to take advantage of the great potential that knowledge transfer brings to the Asia Pacific region identifying opportunities that will allow us to increase productivity in our economies.

Mr José Bustinza, Director of APEC and Specialized Forums from the Ministry of Foreign Affairs of Peru, gave a brief account of APEC and emphasized the many changes of the forum over the last thirty years. The most important, the tenet that the central aspect of trade was to export final products has been replaced by the acceptance of a new essential factor, how to integrate our business into global value chains and the key role of knowledge transfer in this new paradigm.

The opening ceremony wrapped up with an official picture that included authorities, speakers, delegates and staff organizers.

IV. Plenary Sessions Summary

First Day: Wednesday, June 13th

Morning Plenary:

The main purpose of this plenary session was to have a comprehensive review of policies to promote knowledge transfer and focus in the lessons and challenges that developing economies face to promote innovation and the exchange of knowledge. The plenary was given by Mr Pavel Corilloclla.

Mr Pavel Corilloclla is a Doctoral Researcher in Science and Technology Policy Studies, Science Policy Research Unit, SPRU, University of Sussex, United Kingdom. He gave the first plenary lecture of the Workshop with the title **Knowledge Exchange Policies: Lessons and Challenges**.

Mr Pavel´s lecture gave a broad picture of the Knowledge Exchange Framework with special descriptions of the knowledge flow, channels of interactions, actors involved, contexts and factors and policy domains. He was very keen to emphasize the importance of the internal, external and knowledge-intensive business services as key intermediaries between the Knowledge and Technology generators and the users and functioning as knowledge flow modulators. He underlined the complexity of interactions among all these actors and how knowledge flow should be seen not only as going from knowledge producers towards knowledge users but also in the reverse direction, ie. as a bidirectional flow, a sum of complex forward and backward trajectories.

Factors that influence knowledge flow between producers and users such as geography, structure of sectors and disciplines and technology fields were also presented. Similarly, public policy approaches both from the supply-side and from the demand-side as well as public research and innovation policies were examined. Finally, Mr Pavel stated that the right public policy mix -ie. platforms for collaboration and financial instruments- for a specific economy will depend on each economy´s internal factors. There is no such a thing as one-size-fits-all policy for all economies.

Afterrnoon Plenary:

The objective of this plenary session was to share the experiences of China to foster and promote the STI system and news initiatives to increase the technology transfer skills in Chile. The plenaries were given by Dr Ma Leju from China and Dr Alvaro Ossa from Chile.

Dr Ma Leju, Senior expert, International Industries Study Team, DiDi presented his lecture on **Policies to foster and promote the STI System in China**. Dr Leju gave a brief introduction to China policies to foster innovation and began his address stating "innovation does not happen automatically" as the best reason for crafting good public policies. He referred to "China´s Silicon Valley", Zhong Guan Cun, the technology hub in Beijing´s Haidian District as the best example of China´s mass innovation and entrepreneurship where "graduate students create jobs instead of looking for them".

Dr Leju went on to describe the top two China´s innovation policies, the Medium and Long-Term Program for Science and Technology Development from 2006 and the Strategy of Innovation-Driven Development approved ten years later. Accordingly, - Innovation in science and technology must be combined with innovation in system (new ways for government to interact with Universities, private and state-owned companies), management (fostering entrepreneurship among young people through education), business model and culture (social acceptance to new ideas); - Innovation is a long term process; - Innovation should have twin wheels: on one hand Science, Technology, and Innovation and on the other hand Institutional innovation (constant change and update of policies, combining regulations at different levels of government, etc.). One example of institutional innovation comes from Tsinghua University setting two classes of professors, research and academic oriented.; - Transformation in the model of development: value chain, capital chain, industrial chain and innovation chain.

The impact of these two policies has been very positive as investment in R&D has grown in the last 5 years at an average annual rate of 11 percent and China´s successful inroads into manned spaceflight, deep-water exploration, quantum communications and large aircraft development. Other achievements are the construction of high-speed rail, the growth of e-commerce and mobile payments, and the development of the sharing economy sector. In addition, the government´s 2015 initiative, the Internet Plus, the application of the internet and other information technology in conventional industries, has permeated every industry and every field in just three years.

Dr Leju also mentioned the many accomplishments over the years obtained through multilateral and bilateral cooperation as well as the lessons learned from the implementation of the two innovation policies. First, on the role of governance as the Ministry of Science and Technology believes in going beyond mere science and technology management to innovation empowerment to include people´s desires to innovate. Second, the success of China´s integration into the global innovation network. Third, China´s fundamental policy of serving people first by their enabling and empowering for innovation. And fourth, the consistency and coherence of innovation policies with domestic general policy.
Finally, Dr Leju considered some of the most important issues coming up in the next few years in China´s innovation policy such as more public-private partnerships in the two wheels approach; improving closer ties with the real economy; more forward-looking, targeted and strategic research and shared growth through discussion and collaboration with other economies.

Dr Alvaro Ossa, Head of Office Knowledge Transfer and Development, Pontificia Universidad Católica, PUC, Chile, gave the last plenary lecture of the day, **Technology Transfer: from the research to the market**.

Dr Ossa´s lecture centered on three key programs of Technology Transfer developed by PUC from Chile. The first program was a Massive Online Open Course, MOOC, called Technology Transfer: from the research to the market. It was oriented to researchers, academics, technology promoters and undergraduate and graduate students available in Spanish for free on Coursera. It has been a very successful course since in its first 4-5 months had more than 3,000 students from around the world. The goal of this course was "to provide students with the correct and most efficient tools to transform their own research conclusions into products and services that have a positive and meaningful impact on people´s lives". The second program was a six-day course called Summer School: From University to Industry in collaboration with Cambridge University. Finally, the third program named BRIAN (Business Research Accelerator and Innovation) was a science and tech-based entrepreneuship and innovation program, in which were involved more than 150 universities. This program was supported by the private sector through a 500 thousand US dollars grant. Hundreds of teams or entrepreneurs from around the world went through a selection process after a one –week online course and one-week immersion course in Santiago de Chile. The selection process ended with the best 10 teams which received each a 5 to 10 thousand dollars seed capital to develop their projects.

Second Day: Thursday, June 14th

Morning Plenary:

This plenary session was organized to discuss the main mechanisms used in research centers to transfer knowledge. The presentation focused in the tools used by different economies in the APEC area to transfer research outputs. The plenary was given by Dr Ms Soo J. Sohn.
Dr Soo Jeoung Sohn, Associate Research Fellow in the Industrial Technology Strategy Research Division from the Science and Technology Policy Institute (STEPI), in Korea, gave the first plenary lecture on **Knowledge Transfer best practices between APEC economies**.

Dr Sohn gave a comprehensive lecture on the most important theoretical aspects of Knowledge Transfer. After establishing the basic differences between explicit and tacit knowledge, she went on to focus on KT from an industrial perspective. Accordingly, the main reason for trasferring knowledge, explicit knowledge, is for practical use in innovation-based growth and disclosed through intellectual property rights. Economic growth in knowledge-based economies requires high-quality knowledge-based manufacturing rather than resource-based manufacturing. Consequently, high-tech industry requires many technologies for each product (ie. a smart phone includes hundreds of thousands of patented inventions). Since it is very difficult for a single company to have all the technological solutions to manufacture a product the need for KT becomes an obvious occurrence. Another important factor that drives KT is the life cycle of the new technologies which is getting shorter in comparison with older technologies.

Dr Sohn went on to describe each member of what she called the Triangle Squad of Knowledge Transfer, the Knowledge Supplier (Public Institutes, Universities, etc), the Knowledge Demander (new starters, restarters, incumbents and entrants) and the Knowledge Coordinator who connects the supplier with the demander. Knowledge Coordinators must have a good understanding of the technology and market trend.

According to Dr Sohn, there are many obstacles for successful technology transfer, so the success rate of commercialization based on technology transfer is less than 5%. The road from the lab to the market is a funnel that starts with technology transfer in the opening part followed by technology application at the middle and productisation at the tip of the funnel. For Dr Sohn the most important part of the whole process is technology application, also known as the “death valley”, and there is where governments should focus all their efforts.

Dr Sohn went on to compare the US, European and Korean models of Knowledge Transfer where each focus on different actors of the KT process followed by an analysis of an efficient mechanism of KT. She ended her lecture stating that KT is just the beginning for commercialization and that successful commercialization requires many technologies and non-technological factors.

Afterrnoon Plenary:

Dr Ma Leju, Senior expert, International Industries Study Team, DiDi, gave the first lecture of the afternoon plenary session on **Policies and mechanisms to create synergy among academia, industry and government (Case studies)**.

Dr Leju presented three case studies as examples of China´s policy and mechanisms to create synergy among academia, industry and government. The first case study came from the Academia and was referred as ***Science Advisory in Ruoergai***, China. Ruoergai is a very remote county in the central part of China located at 3400 meters above sea level and with an annual average temperature of 1.1 °C. In this case study, the Chief Engineer of Sichuan Geology Inspection Institute took over two government positions both as a Deputy Secretary General, Ruoergai governing council and Deputy Chief, People´s Government of Ruoergai County. In this program, research institutes send their reseachers, scientists or engineers for 1-2 years to work as government officials in counties or cities across China. This is part of institutional innovation. In this special case study, the outcomes were the development of projects in skill training, education and science communication (citizens learn what science is all about), funding for infrastructure and science and technology research, platform of science and technology experts (to foster a sustain science advice to city governments) and new dynamism in tourism (establishment of a park in this remote area to foster tourism).

The second case study came from the Government through the ***Talented Young Scientist Program*** (TYSP), an international mobility scheme funded by the chinese government aimed at cultivating future research leaders together with other developing economies. TYSP promotes cross-border exchanges of gifted young scientists, scholars and researchers among research institutes, universities and industry. TYSP sponsors talented young scientists from developing economies to come to China to work for 6 or 12 months under the direction of a senior scientist, professor or mentor. The idea is to train people from another economies and establish long-term collaborations with them upon their return. This program is also a good example of institutional innovation.

The third case study came from Industry, ***Sharing Economy for Digital Future***. Specifically, DiDi, a six-year ride-sharing, Artificial Intelligence and autonomous technology startup with a very young workforce, average age of 26 years, of almost 9,000 employees. The company provides a large variety of transportation services for more than 450 million users across over 400 chinese cities via a smartphone application. The company carries 25 million rides a day.

DiDi has become the second most valuable start-up company in the world with over 56 billion US dollars worth of valuation. This company right from the very beginning went to universities to inspire young students to develop entrepreneurship. Also, it brings real world transportation problems as research topics and invites young professors and university students to come up with solutions. Finally, the company works very close with city governments in solving transportation problems.

Dr Mónica Alandete-Sáez, Director of Analysis & Education at PIPRA (Public Intellectual Property Resource for Agriculture based on the University of California, Davis), gave the last lecture of the second day, **Public Intellectual Property Resource for Agriculture – UC Davis.**

Dr Alandete-Sáez talked about PIPRA, a non-profit organization created by the Rockefeller and McKnight Foundations in 2004. Its mission is to "enable technologies developed in the public sector to have the broadest possible impact in society facilitating IP management tools to accomplish successful technology transfer for public benefit". Dr Alan B. Bennett leads PIPRA as its Executive Director since 2008. He is also the Executive Director of the UC Davis-Chile Center of Excellence since 2014. PIPRA carries out several activities towards capacity building and training programs. Specifically, it provides Institutional IP Policy Support, Portfolio Management and Freedom-to-Operate, FTO, Analysis, Institutional Needs Assessments and Commercialization capacities among others.

Dr Alandete-Sáez commented on PIPRA´s star program, the Licensing Academy which is a two-week summer program which has trained more than 275 participants from more than 50 economies in the last 8 years. The summer course combines lectures, discussions, case study analysis towards a comprehensive understanding of how to manage IP to maximize commercial success and social impact. It targets IP managers, lawyers, scientists, graduate students, etc. In 2013 a Latin American version of the Licensing Academy was created in Mexico with the help of the Organization of American States which has trained 115 professionals from 17 economies across the Americas.

Finally, Dr Alandete-Sáez talked about the UC Davis Chile Center of Excellence focused into agriculture and the life sciences and launched as recently as 2015. The original partners were three Chilean universities, Universidad de Tarapacá, Universidad Andrés Bello and Universidad de Talca and two private companies from the wine sector, Concha y Toro and Viña San Pedro. The idea is to develop collaborative research between UC Davis and Chilean researchers to develop disruptive new discoveries/technologies and accelerate their translation into products and services, primarily into agri-food and environmental sectors. The Center serves as an international hub for UC Davis in Latin America. It builds capacity for education, research and technology transfer in Chile. The two pillars of the Center are Research and Development and Technology Management Transfer. The Research and

Development has four main areas: New Genomic Tools, Bioproducts, Climate smart-agro and Integrated Pest Management.

Third Day: Friday, June 15th

Plenary session

Dr Lai Oi Ming, Member of the UPM´s Intellectual Property Evaluation Committee, University Putra Malaysia – Putra Science Park, gave the last plenary lecture of the Workshop, **Knowledge Transfer and Innovation Science Park: A case study of University Putra Malaysia´s Innohub**.

Dr Oi Ming began her talk describing the need for transformation at UPM´s which has driven the establishment of the University Science Park perfectly aligned with the Malaysia´s need for transformation. UPM started as an agricultural college in the 1900´s. More than a hundred years later is a full-fledged university with more than 2200 faculty.

Dr Oi Ming went on to briefly describe a very important public policy tool, the Malaysia Education Blueprint for 2015-2025 which states that the economy needs to strengthen Techology Transfer Offices at Universities so the information and knowledge generated reach the public. Next, she continued with a brief account of the making of Putra Science Park (PSP) which started as University Business Center back in 1998, changed to Innovation and Commercialization Center (ICC) in 2006 and finally became PSP in november of 2012.

Through all of this years the government and universities gave a series of incentive to professors to become involved in innovation. Actually, filing a patent or being involved in technology commercialization became a requirement for professors promotion. Moreover, at UPM undergraduate students are exposed to innovation, IPR and technology commercialisation very early in their education. Later on, students are required to become involved in social innovations as well as social entreprises.

At UPM, this focus in innovation and excellence during the last 20 years has resulted in a big shift in research themes. Before the year 2000, most of the research was focused on rubber technology and agriculture, later (2001-2010) research themes became more diversified including vaccine development, optical fiber, nutraceuticals, anti-cancer compounds, nanotechnology, amomg others.

Finally, from 2010 and on research priorities have become broader and sophisticated, from high technology materials, medical devices, nanocomposite, biobased products, to biofertilizers and electrical devices.

Dr Oi Ming went on to describe how the InnoHub program came about at UPM as an effort to mitigate the problems associated to what is known in the technology commercialization process as the “death valley”, somewhere between the making of a prototype and the first round of financing. It was soon realized that just licensing IP to companies was not enough for a TT office as more had to be done to secure success in technology commercialization. So empowering technopreneurs to build their road to the market became InnoHub vision. Very early in the IP management process, researchers have to decide if they want to commercialize their technology. In order to facilitate this path, University´s rules had to change allowing professors to take a leave to develop their own companies.
InnoHub program develops through four steps: engagement, lean market validation, lead monitoring and fund raising. Also, a network and training of Innovation champions have been established from each faculty. Services provided by InnoHub include: shared space and facilities, matching of startups management, mentoring and coaching, education and training, IP advisory, business support and fund raising. So far PSP achievements are more than 2,000 IP filed from which a total of 137 have been commercialized resulting in 54 total startups and more than 14.8 millions USD in sales.

V. Thematic Sessions Summary

Agriculture

First day: Policies to promote KT

The Thematic Session in Agriculture started with a lecture given by Dr Mónica Alandete-Sáez, Director of Analysis & Education at PIPRA (Public Intellectual Property Resource for Agriculture based on the University of California, Davis). Her lecture set the tone for the whole session.

She introduced the concept that in developed economies agricultural research and development has become a private asset which has created Intellectual Property challenges for public research and indeed, it is one of the most important forces driving the future of intellectual property rights in Agriculture and Food Systems.

The shift from public to private R&D in Agriculture, in high-income economies, started by the turn of the century. For example in the USA, private- and public-sector spending was approximately 50% in the year 2000. However, by 2013, the public share of total R&D spending had declined to about 25%. Indeed, nowadays roughly 75% of total food and agricultural R&D in OECD economies is private. However, in developing economies it is just the opposite, in Perú, for example, public sponsored research is still dominant with about 80% of total expenditures.

Dr Alandete-Saéz also pondered on the other major forces driving IPRs in Agriculture and Food Systems such as the mainstreaming of the commercial channels for distribution of agricultural innovations, the high cost of agricultural biotechnology applications and the increasing technological sophistication and investment in the agricultural sector.

At the end of her lecture, she concluded by stating that "Intellectual Property will not feed the world but it does provide the intangible infrastructure that enables innovation and progress in genetics, applications of big data and synthetic biology that will. Public research institutions need the capacity to transfer technology (and IP) to commercial partners".

The debate that ensued Dr Alandete-Saéz´s lecture centered about the new scenario in agricultural R&D and the growing importance of IPRs as instruments of public policy for fostering technology transfer. One main concern though was the protection of traditional knowledge from big companies IPRs. However, there was a consensus about the importance of strong patent laws for technology transfer. In addition, in all the economies the roll of the public sector was very important for agricultural research financing.

Second day: Mechanism to an effective KT

Dr Mónica Alandete-Sáez, Director of Analysis & Education at PIPRA (Public Intellectual Property Resource for Agriculture based on the University of California, Davis) gave the second lecture of the thematic session in agriculture and started by describing the State of California University System with its 10 campus but a largely decentralized decision-making institution. She commented, with data from 2012, on how the large number of active patents, 4,118, and invention disclosures, 1,776 resulted in 61 start-up companies formed and 119.2 million USD collected in licensing revenue only for that year. Although very impressive results, Dr Alandete-Sáez pointed out that more important than the licensing fees collected every year is the economic impact of the research investment, 3.35 billion USD, which translates into 46.3 billion USD in the economy plus 430,000 jobs. Accordingly, she emphasized that technology transfer is not about licensing fees at all but about the economic and social impact of the technology commercialization derived from that research.

Dr Alandete-Sáez went on to define innovation as the "process of translating an idea or invention into a product or service that creates value" and stated "the translational process between the idea and the innovation is neither easy or automatic, it requires expertise and a culture that is not present in the majority of universities". She added that it is very important to form an alliance between the Technology

Transfer Office and the private sector which has the capital investment and manufacturing capability, regulation expertise, etc. In consequence, the UC Davis model for Technology Transfer requires a very technical-minded team which can communicate with the inventors and at the same time a very good understanding of what innovation is and how it is developed. Also, a very strong expertise in legal and policy framework to manage IP. Each campus has its own TTO with a strong Technology Transfer and Business Development Services.

Dr Alandete-Sáez highlighted the critical role of the Bayh-Dole Act has played as the basis of the legal framework to manage IP at universities. According to this piece of legislation universities may elect title to inventions developed through Federal funding but must file patents on inventions they elect. In addition, universities must have written agreements with faculty and staff requiring disclosure and assignments of inventions and share portion of revenue with inventors. Accordingly, the University of California´s IP policy (1997) includes an obligation from the faculty to disclose inventions and assign IPRs to UC. In return the inventors receive 35% of the net profits.

UC Davis TTO has a combination of different licensing strategies that go from non-exclusive license (ie. plant varieties with no further need for additional R&D) to exclusive license for high end technology that requires strong R&D effort from the company. Dr Alandete-Sáez presented several case studies for each licensing strategy and emphasized the importance of developing a worldwide IP protection strategy.

The debate that followed this lecture centered about different topics ranging of how to protect plant varieties in the international market through the use of molecular markers to the role of regulatory agencies and the importance of fieldwork. Afterwards delegates exposed their case study related to the thematic session. David Molina from Chile, talked about how important was for CORFO to normalize the different regulations among university and research institutions (2014) by setting clearly conflict interests issues, when and how to create start-ups, requirements for emerging technologies to be protected, etc. Patricia Ocampo from Mexico talked about the process of certifying of Technology Transfer Offices carried out by CONACYT to prevent their proliferation and secure a quality standard. Julius Caesar Sicat from The Philippines talked about the process of formation of Research Consortia in Agriculture, Energy and Health each with private and public universities and how each consortia developed their own Technology Transfer Office. Zakwan bin Azahari from Malaysia talked about the importance of the farmers in the technology transfer process decision. Pavel Corilloclla from University of Sussex talked about the setting up of Centers of Excellence, first in Chile and now in Peru, and the technology transfer at these centers. Sara Quinteros from INDECOPI, Peru, talked about the peruvian regulations about tha plant varieties commercialization. Gino Gregorio from CONCYTEC, Peru commented on the new tax incentive program to foster private investment in research, development and innovation. Finally, Alvaro Cabezas from Inka Traditions, a private company involved with highland communities to foster innovation.

Aquaculture & Fishing

First day: Policies to promote KT

The thematic session started with a lecture given by Ms Daniela Hurtado titled, Policies Associated with Science, Technology and Innovation in Fisheries and Aquaculture. Briefly, she referred to the Peruvian Policy for the Fisheries and Aquaculture Subsector, which is being developed by the Ministry of Production (PRODUCE), in collaboration with FAO. This document will mark the fishing and aquaculture management policy in the Peruvian economy in the next few years. Currently, several focus groups are being carried out with different stakeholders around the economy. The information gathered will serve to prepare a diagnosis of the current situation of the fisheries and aquaculture subsector.
Ms Hurtado went on to describe the Program for Innovation in Fisheries and Aquaculture, lauched at the end of last year, whose goal is to locate Peru in 2021 among the first three aquaculture producers

in Latin America and make it an important global competitor in the fishing for direct human consumption. The general objective of this program is to strengthen the ecosystem capacity in the delivery of innovations in the subsector value chain. The program has four components: the first component will strengthen the economy´s capacity in promoting innovation in the fisheries subsector and support a competitive grant program to fund successful proposals. The second component will promote innovation in the aquaculture subsector and also finance a competitive grant mechanism to assist in the generation of knowledge and the development of proposals. The third component is designed to strengthen the Innovation System in Fisheries and Aquaculture, institutions and policies to enhance profitability, and ensuring sustainability in the subsector. Finally, the fourth component will finance the management of the program.

The dialog that followed among delegates positioned different economies scenarios in fisheries and aquaculture research and development and the importance of developing appropriate public policy tools for promoting technology transfer. Also, delegates exposed their case study related to the thematic session.

Second day: Mechanism to an effective KT

This presentation was delivered by M.Sc. Fabricio Flores Ysla, Head of the Aquaculture Innovation Unit of the Program for Innovation in Fisheries and Aquaculture. Mr Flores started by highlighting the new development strategy in the subsector fisheries and aquaculture, a healthy change from the current extractive model to one where it predominates a more sustainable approach. Mr Flores underscored the rapid transformation in the way of promoting research and development in the subsector. The current R&D model, generally demand-driven, financed by public funds, and with emphasis in basic research will be gradually replaced by a model with a heavier role of the private sector and directed towards applied research and technology development. Mr Flores went on to explain the renewal in the governance of the System for Innovation in Fisheries and Aquaculture, SNIPA, based now on public and private networks, a reform of the regulatory framework, the development of new policies and instruments, the implementation of a surveillance and technological prospective system and the execution of a monitoring and evaluation system. Also, Mr Flores stressed the decentralized approach and social inclusion emphasis in the promotion of innovation in the fisheries and aquaculture subsector. The expected results for the aquaculture sector includes the development of new business models and more diverse and articulated value chains. Finally, he summarized the expected impacts of the program towards 2022.

The discussion that ensued among the session delegates described, as before, different economies approaches to research and development in fisheries and aquaculture and the importance of developing appropriate public mechanisms for promoting technology transfer. Also, delegates exposed their case study related to the thematic session.


NATIONAL PROGRAM OF INNOVATION IN FISHERIES AND AQUACULTURE
NATIONAL ESTRATEGY OF INNOVATION IN FISHERIES AND AQUACULTURE.


APEC

Health

First day: Policies to promote KT

The Thematic Session in Health started with a lecture given by Dr Marli Elizabeth Reatter Dos Santos, Technology Transfer Advisor, Pontifical Catholic University of Rio Grande do Sul. Her lecture Policies for Knowledge Transfer in the Health Sector set the tone for the whole thematic session.

Dr Reatter Dos Santos started her talk by underlining the new trends in intellectual property policies at public research organizations (PROs). Policies with a closer interaction with industry and a stronger emphasis in IP protection through legislative reforms. She went on to describe the technology transfer process which generally starts with an invention and it is followed by an invention disclosure, assessment, protection, marketing, licensing and ends with a financial return which then could facilitate a new invention.

Dr Reatter Dos Santos continued to define what IP and Knowledge Transfer institutional policies are for. In general, these policies define the obligations of employees, students and visiting researchers, specially the obligation to report invention disclosures. Also, they define the decision process regarding IP management and knowledge transfer and set the guidelines for the creation of start-ups by their researchers. Similarly, they stipulate the economic gains of the inventors, such as conditions and percentage distributions, and establish the IP rights in cooperative projects with companies.

Dr Reatter Dos Santos emphasized that KT in the health sector is more that a question of “bricks and mortar”. In general, it involves many channels, all of which improve the economic capabilities of the recipient firm. Specifically, it may involve the transfer of physical objects such as equipment for use in research laboratories –the so called “techno-ware”. Also, the skills and human aspects of technology management and learning –the “human-ware”; the techniques related to knowledge, information amd technology –the “info-ware” and the organizational and procedural knowledge needed to operate a given technology –the “organ-ware”. A check list for a policy for KT in the health sector includes a viable and accesible local market, political stability and transparent economic governance, proper access to information, adherence to high regulatory standards, appropriate capital markets, skilled workforce, clear economic development priorities and innovation-friendly environment with sound IP rights.

Second day: Mechanism to an effective KT

The thematic lecture for Mechanisms for KT in the Health Sector was given by Dr Marli Elizabeth Reatter Dos Santos, Technology Transfer Advisor, Pontifical Catholic University of Rio Grande do Sul.

Dr Reatter Dos Santos itemized the different mechanisms for technology transfer between the university and the company as Intellectual Property and several linkage activities such as technological, training and information services, R&D projects, business incubators and the creation of spin-offs. She also went on to define the role of technology transfer as bridging the so called “death valley”, ie. the gap between academic-based innovations and their commercial application in the marketplace.

Dr Reatter Dos Santos noted that in the health sector, translational research is regarded as an excellent approach to speed up technological innovation from the bench to bedside and in doing so bring basic research results to needed applications. This research in turn is broken down into different stages such as preclinical studies, clinicals trials phase I, II and III. Accordingly, drug development is a long process -10 to 15 years, expensive –from 200 million up to 1 billion USD and uncertain –up to one in 300 or more chance.

Dr Reatter Dos Santos also added that technology transfer in the health sector usually takes place under any of these three arrangements: licensing of preexisting technologies, collaborative or sponsored research agreements to develop new technologies or the formation of start-up companies, financed by VC groups.

Dr Reatter Dos Santos gave some examples of KT in the health sector that included scientific knowledge transfers via research collaborations; building public health capacity through training and education; raising local production quality through joint ventures and licensed manufacturing; training of local health workforces; screening or sharing of compund libraries; sharing of know-how through clinical trials, training and management, among others.

Finally, Dr Reatter Dos Santos listed several contracts and agreements for technology transfer in the health sector such as material transfer agreement (MTA), confidentiality agreement (CDA/NDA), licensing agreement, start-up company licenses, distribution of royalties, collaborative research contract, sponsored research contract, inter-institutional contracts (IIA), etc.

VI. Wrap Up Session

The Wrap Up session was conduct by Dr Luis De Stefano Beltran, Senior Research at Universidad Peruana Cayetano Heredia. Dr De Stefano summarized the plenary and thematic sessions and gave the main guidelines to promote knowledge transfer in APEC economies. A comprehensive and detailed policy recommendations extract from the Workshop can be read in the document: “policy recommendations to promote knowledge transfer”.

Agriculture Sector

1. In developing economies public research still is dominant but it imposes the need to increase their performance in both sophisticated research and technology transfer capacity.
2. Need to strengthen IP regulations to promote TT in the form of new seeds through commercial channels. In the case of Peru, there is a need to promote Peruvian companies in the seed industry.
3. Need to balance the rights of Indigenous communities and big companies interests.

Aquaculture Sector

1. One of the main challenges is to move from an extractive development model to another for culture development, and this will be done by connecting market opportunities with ideas and development projects
2. There is an emerging role for the private sector as producer of research goods. There is a need for public policies to foster them.
3. Government role still is important in TT specially in developing economies.

Health sector:

1. There are institutions in Peru like Peruvian NIH and INDECOPI that have a role in the knowledge transfer with education (INDECOPI) and research rules (NIH).
2. The roles of universities and industries are quiet different, the universities create new knowledge and have pure curiosity driven research but industries develop new products, these roles create a “death valley”. Translational research bridging this “death valley”. There is need of public policies to fill this gap.
3. Universities research projects are not only about pharmaceutical products, there are also IT projects, social innovation projects, among others. There is a need to foster these activities through public financing.

Mining Sector

1. The universities' Offices for Knowledge Transfer should focus in the comercialization of their technologies to ensure their sustainability.
2. There is a cultural gap between the research and commercial personnel that makes the formers avoid sharing their findings even between their colleages. This issue can be solved with incentives like prizes as most researchers are fond of these kind of incentives.
3. The policies for knowledge transfer in mining should include in their vision ways for improving the quality of life of the people who like in the villages around the mines.
4. Due to the previous point, mining companies may not be interested in applying to innovation grant funds. Instead it would be better to involve these companies in the development of new technologies.


40%
Share of worldwide employment in agriculture (including 70% of the "bottom billion")
70%
Share of worldwide water withdrawals from agriculture
10,000
Years of historical food production that must be matched in the next 50 years
925,000,000


SALIDA


APEC
Asia-Pacific
Economic Cooperation
Knowledge Transfer
Best Practices between
APEC Economies

VII. Outputs

1. PAPER ON POLICY RECOMMENDATIONS TO PROMOTE KNOWLEDGE TRANFER BETWEEN APEC ECONOMIES

Introduction

The APEC economies face specific challenges as a region and a way to address these in the best possible way is to increase the transfer of tangible and intellectual property, expertise, learning and skills between academia and the non-academic community between the APEC Economies. Knowledge Transfer (KT) is a term used to encompass a very broad range of activities to support mutually beneficial collaborations between universities, businesses, public sector and society. KT provides a significant driving force for enhancing economic growth and societal wellbeing. For academics, KT can be a way of gaining new perspectives on possible directions and approaches for research. This two-way exchange element of KT is at the heart of successful and sustainable collaboration.

The Knowledge Transfer best practices between APEC Economies, (13th – 15th June 2018, Lima city) aimed to create a platform for policy makers, scientists, academics and private sector representatives, to interact and share information and experiences in order to implement effective mechanisms to encourage Knowledge Transfer.

The project intended to foster the exchange of best practices among relevant stakeholders of the innovation ecosystems in APEC economies; targeting the knowledge transfer concept as a key factor to create value among the knowledge chain. As well to encourage collaboration of the implementation of policies related with Knowledge Transfer, through different experiences and models of APEC economies.

This project considers as a general understanding and as starting point, that Knowledge Transfer is the movement of knowledge (from the scientific and technological production) for the public benefit; in other words, the use of research and technological outcomes to improve practices, in order to implement initiatives and to tackle specific problems.

The APEC economies have developed their own models to encourage the exploitation of the scientific and technological outcomes, with the aim to generate added-value in products and services to solve social needs and to create new market opportunities. Through the implementation of a Knowledge Transfer network, the project aims to share through the analysis of (selected) APEC economies' models, best practices, experiences and strategic information, that will result in the benefit of regional cooperation.

The Report: Policy recommendations to promote knowledge transfer, is a compilation of the main ideas discussed during the Workshop. The discussion focused on two general topics: 1) public policies to promote knowledge transfer and 2) mechanism to an effective knowledge transfer. Both included a sectorial approach in health, mining, and agriculture. The report aims to set out guidelines to be incorporated by policy makers and foster knowledge transfer in APEC region.

Additionally, the report is complementary with other efforts and projects supported by PPSTI – APEC.

Policy Recommendations

The policy recommendations presented below have been elaborated from the activities developed in the Workshop on Knowledge Transfer Best Practices between APEC Economies. The workshop included plenary sessions, thematic sessions, and case report discussions. The document also contains the opinions of experts and delegates who participated, many of them from academia, government and business sector.

The recommendations are organized in general and sectoral. The first ones are taken from the plenary sessions, focusing on the policies and mechanisms to promote knowledge transfer. On the other hand, the sectoral recommendations are taken from the thematic sessions and case reports developed by the participating delegates.

The policy recommendations presented here are suggested lines of action for APEC economies to increase levels of knowledge transfer.

1.1 GENERAL POLICY RECOMMENDATIONS

1.1.1 Policies to promote knowledge transfer

Many economies around the world have several concerns about how to promote knowledge and technology transfer in their innovation systems. Economies around the world have been implemented different policies to increase technology and links between universities and companies, in order to be more competitive. However, there is still a gap between the knowledge that is generated and the knowledge that is used. This implies rethinking the way in which technology transfer is being made and how it is understood.

Knowledge and technology transfer is a complex system that implies several actors: producers, users, intermediaries, as well as different channels: informal relationships, formal agreements, physical facilities, training, joint research, and others. In addition, technology transfer happens in different environments delimited by geography, sectoral patterns, and technical fields.

The knowledge transfer policies must consider all the aspects mentioned above, taking into consideration a supply - side and demand side approach that allows economies linking the public research policy and the innovation policy.
In this context, the next guidelines to set up knowledge transfer policies are proposed:

Policy guidelines

1. Knowledge and technology have two directions, from producers to users and vice versa. Policymakers should consider this two-way flow and **design policies focusing on supply and demand.**

2. Technology transfer implies different mechanisms not only patent licensing and spin-off creation. **Public policy needs to consider a wide range of instruments to promote knowledge transfer** not only instruments related to commercialization. These other instruments include research collaboration, research mobilizations, academia-industry meetings, and others.

3. The creation of spin-offs from the knowledge generated by research organizations has great advantages as a technology transfer mechanism. Technology transfer policy has to **incorporate specific objectives to promote spin-offs creation.**

4. Informal relationships are one of the most important interaction channels considered by firms and researchers. Policymakers have to **promote new spaces to interaction and networking.** There has to be a platform where research and industry regular meet and

inform each other what's happening in the market and in the research community. This is also an opportunity for researchers to understand how the market operates, and industry is able to advise researchers on what the market needs. **This effort should complementary with other channels considered in the public policy.**

5. Public policy has to take into consideration that researchers and firms do not use technology transfer only for commercialization or economic purpose. Firms work using conferences, scientific publications, and other kinds of channels in order to develop a specific technology project and build capabilities for innovation (absorptive capacities). In the case of universities is similar. Researchers working in collaboration and use different interaction channels because they are interested in complementary capacities. **This should be considered at the moment of creating new incentives for knowledge transfer.**

6. The intermediaries are very important in the technology transfer process. Public policy should be considered three kinds of intermediaries: internal intermediaries, external intermediaries, and knowledge – intensive business. Internal intermediaries refer to the Technology Transfer Office inside of a university or similar. External intermediaries refers a set of organizations that help out to connect research to market. Knowledge – intensive business like Ventures capital specialized in a main technical area provide found to Spin outs. **The technology transfer policy has to consider promoting and strength the role of intermediaries** in order to get a fluid flow between knowledge producers and knowledge users.

7. Technology transfer policies have to consider how the **geography (regional and local), productive sectors, and technology fields shape the actors behaviours and activities** they do in the technology transfer process.

8. Alignment of technology transfer with economic development priorities. The limited resources available to governments imply develop a realistic policy and plan related to technology transfer. **The goal settles up in the policy have to consider social and economic needs, as well as the implementer's capacities**. Take into consideration at the moment to elaborate a technology transfer policy that the creation of completely new types of economic activities will present bigger challenges than already exist.

9. Innovation policy has to **identify R&D niche areas in which economies may have the competitive advantage** in future development and where technology transfer can be relevant. In addition, is necessary that technology transfer involves **direct cooperation between public research institutes with local industry.** The cooperation will increase the success rate of commercialization and technology transfer.

10. In order to get a sustainable technology transfer, it is important for APEC Economies to **foster an investment climate where venture capitalists and angel investors thrive.** Governments should promote programs to attract investment and close gaps in this area.

11. Support for proof of technology. Most of companies do not want to take too high risk. So they want last stage of development to make sure that the technology works well in pilot/industrial scale with desirable quality and specification. With limited resources, the **government has to consider creating funds and other kind of support in order to implement facilities** for pilot test and testing facilities. This could accelerate the technology transfer process.

12. Need of skilled professionals in Technology Transfer. Technology transfer experts are not easy to find all over the world. A person who is good at science with business understanding, can be trusted and appreciated by researchers, as well as being able to deal with the business sector. **Technology transfer policies need to promote the capacity building programs, including support for developing capabilities for managing technology transfer offices.** An association or network of technology transfer professionals is important for continuing learning and possible certification programs.

1.2 MECHANISMS TO AN EFFECTIVE TECHNOLOGY TRANSFER

Economic Growth in Knowledge-Based Economies requires (high-quality) knowledge-based manufacturing. It implies the creation of high-tech industries and specialized jobs. In a high-tech industry, many technologies are required for each product that a single company cannot have all of them due to resource limitations (Researchers, IPRs, Fund, etc.).

Another point to be considered related to knowledge transfer is the technology "life–cycle". Nowadays, technology evolves accelerate and high tech markets are increasing the demand for new technology. Companies must work with strategic partners that have or produce technologies.

Knowledge transfer implies the interaction of actors with different purposes: knowledge suppliers (Universities, Public Institutes, Private Corporates, Personal investor); Knowledge demander (new starter, restaurateur, incumbent, entrant); and knowledge coordinator (TTO, R&D service provider, Investor). Many of the interactions between the actors must be based on confidence. This is a challenge to governmental organizations that promote knowledge transfer and for actors in general.

Knowledge and technology transfer should consider the guidelines aforementioned in their activities:

Policy guidelines

1. **Establish a robust IP regulation in the organization and promote innovation culture.** Regulations and clear policy will allow stakeholders work effectively in their path and spend less time with negotiation. On the other hand, researchers do not feel motivated to develop technology transfer activities mainly due to their preference in supporting basic research and the generation of publications in indexed journals. Public and private organizations (universities, research centres, and enterprises) should promote an innovation and technology transfer culture.

2. Knowledge transfer implies the interaction between suppliers, demanders, and coordinators. These interactions must be based on trust. **Knowledge Transfer Managers in the supply side, demand side, and coordination side, have to consider a mechanism to build confidence with other actors.**

3. Coordinator plays a fundamental role in knowledge transfer, connecting suppliers with technology demanders. **Coordinators (technology transfer managers) must have a good understanding of technology and market trend.** Policy makers should promote specialized courses or training oriented to develop technology and market capabilities.

4. Knowledge transfer is a process with three main factors to be considered: players, the platform, and framework (pipeline). Players vary depend on the role in the process (supply, demand, coordination). Platform refers to the spaces and facilities that players have to do knowledge transfer (laboratories, incubators, TTO, others). Finally, framework refers to the institutional infrastructures (Law, Basic plan, etc.), R&D funds, consensus, and global networks. **Knowledge Transfer Managers have to take in consideration that an adequate framework facilitates the connection between players through incentives and stimulus.**

   In order to achieve knowledge transfer objectives, TTO or similar should consider the next:

   - **Identify capabilities:** What are the main capabilities that an organization have in terms of knowledge, resources, infrastructure, manpower, legal system, etc.
   - **Investigate partners:** Who are the partners that organization has (knowledge supplier, funding provider, technical and business experts, others) and what kind of partners the organization need.

- **Build growth strategies:** What kind of StartUp the ecosystem has (high – tech StartUp or Internet Based StartUp´) and what types of market are available (current/future, strategic industries, others).

5. Knowledge transfer is just the beginning step for commercialization to achieve the objectives previously settled up. TTO managers should **take into consideration other factors that influence in the process like culture, infrastructure, institutions, funds, etc.)**. In addition, in order to achieve a successful knowledge transfer many **technological and non-technological factors (design, marketing, etc.) should be combined.**

6. Inventors/researchers play important roles in the process of technology transfer, especially in developing economies because companies may not yet be ready to adopt the technology. Research organizations and TTO should **promote that inventors/ researchers to work in companies, mainly through research stays.**

7. **Participate in networks will benefit technology transfer**, not only to match technology seekers or investors with technology providers but also bringing other needs in the technology transfer processes. TTO manager should participate actively in innovation networks.

8. Research institutions –by means of their TTO- rarely evaluate rigorously the best transfer strategy. Patenting is not always the best alternative; it depends on factors such as the level of inventiveness and the maturity of the technology and of specific logics of each productive sector. **TTO managers have to evaluate alternatives to propose an effective and realistic technology transfer strategy.**

9. When a company wants to test a technology, **negotiate a license option with specific criteria according to the company expectations.** Additionally, is necessary **involve researchers with promising results with industry actors**, so they can define which features of their technology are relevant and the desirable conditions to test them.

10. Always **consider budget for IP protection in public founded projects** and **take advantage of the 30 months of PCT to perform commercialization** efforts in most attractive markets. If a licensee is found, try to pay the patent cost with upfront fees of the deal.

11. In the cooperative project with industry**, understand the commercial plan of the company for the technology**, so you can provide the necessary IP rights, territories and applications. With a clear plan, it's easier to establish milestones in the licensing agreement and monitor the correct use of the technology.

12. Research organizations **need to define its governance and processes to be nimble** enabling speedy actions like setting up spinoff companies, technology transfer transactions and hedging technology obsolescence.

1.3 SECTORIAL POLICY RECOMMENDATIONS

The policy recommendations drawn from the thematic sessions are presented below. It must be borne in mind that many of the recommendations addresses different productive sectors, some of which are non-specific. In that sense, there may be coincidences between the recommendations that are given at the sectoral level and those that were mentioned for the general level.

1.3.1 Policy recommendations in mining sector

Policy guidelines

1. The universities' Offices for Knowledge Transfer should **focus in the commercialization of their technologies to ensure their sustainability**.

2. There is a cultural gap between the research and commercial personnel that makes researchers avoid sharing their findings even among their colleagues. This issue can be solved with incentives like prizes, as most of them are fond of these kinds of incentives

3. The policies for knowledge transfer in mining should include in their vision ways for **improving the quality of life of the people who live in the villages around the mines**.

4. Due to the previous point, mining companies may not be interested in applying for innovation grant funds. Instead, it would be better to **involve these companies in the development of new technologies.**

5. **Knowledge transfer policies have to focus on a long-term period.** This policy has to be set up thinking in what we will need in 25 or 30 years and not concentrate only on our current need.

6. **Promote cooperation between the productive sector and research institutions using a set of instruments like tax policies, public funding, credits, and others.** Each economy has to arrange the instruments taking in consideration the ecosystem level and the grade of cooperation.

7. Governments should make an effort to prioritize areas in which each economy has comparative advantages. The **priority should consider the capabilities and resources that each economy has and the goals they want to achieve**.

8. Governments should **support companies with limited access to financing focused on SME**. In general, SMEs are available to conduct R&D projects, or link with industry, but it has several constraints to get funds.

9. Reduce fragmentation and duplication in the delivery of government support. **A mixed policy approach should be considered to design and implement knowledge transfer policies and support actions.**

10. Promote activities to orient the interests of students towards market demands. Postgraduate students in all areas are a great resource for new ideas and market needed solutions. In addition, it is necessary to **increase the collaboration between students that come from different departments.**

11. **Improve the ability** to effectively enforce intellectual property rules.

1.3.2 Policy recommendations in agriculture sector

Nowadays there are some factors that drive the future of IPRs in agriculture and food system that governments need to consider at the moment to elaborate public policies:

- The shift from public to private research in agriculture: In the developed economies the contribution of the private industry to agriculture innovation is growing a lot faster than the contribution from public institutions. Roughly 75% of total food and agricultural R&D in OECD economies is private. On the other hand, in developing economies the major contribution to agricultural R&D comes from public institutions.

- The necessity to create channels for distribution of agricultural innovations: There is a challenge to create new incentives to local or not companies to distribute agricultural innovations.

- The high cost of agricultural biotechnology applications: The cost associated to agricultural has a strong reliance on intellectual property because it implies a higher cost to apply and maintain patens. On the other hand, is very expensive to get access to enable technologies that allow create new innovations. This creates barriers to innovate.

- Increasing technological sophistication and investment associated with agriculture: Emerging technologies as a result of combining different technologies (biotech, big data, AI, others) are increasing the optimization of agricultural management. This is known as a "precision agriculture".

Policy guidelines

1. In many cases researches discover or adapt innovations that come from ancestry knowledge. **This knowledge generated in a social environment that lay in farmers.** Knowledge transfer policies have to consider this point in order to redistribute the benefits of agricultural innovations to farmers and society in general.

2. Do to the interest for agriculture and food in the social and environmental issues, **technology transfer and intellectual property rights in this area has to consider "ethical aspects**". IPR must not be an obstacle to achieve the objectives related to food security.

3. In developing economies the contribution of public funds to agricultural R&D represent a vast amount of resources. Therefore, technology transfer should **consider liberate IPR in order to avoid the creation of barriers to use and disseminate the innovations**.

4. Governments should elaborate public policies and programs that help to preserve traditional knowledge in the public domain. **Policies and programs have to differentiate which kind of knowledge or technology have to be offered free in order to facilitate the public access to this technology**.

5. Technology transfer need specialized capabilities to be conduct efficiently. **Policies in technology transfer have to consider the generation of indigenous capabilities** particularly in a sector like agriculture.

6. Need to balance the rights of indigenous communities and big companies' interests.

7. **Establish an efficient agricultural technology transfer and promotion operating mechanism.** This is conducive to the promotion and transformation of university technological achievements, promoting the development of agricultural modernization, and promoting the construction of local regional economies. It also enables the university's discipline construction and personnel training to be closely integrated with current agricultural development.

8. **Establish an efficient financial support system.** Agriculture is a weak industry that bears the dual risks of nature and the market. The government's strong financial support is an important support for the formation and transformation of agricultural scientific and technological achievements and directly affects the development of the agricultural economy.

9. **Make efforts for the construction of agricultural technicians.** Consider the demand for personal training in the regional economy and new rural construction, and rationally adjust personnel training plans to better serve the construction of new rural areas and regional economic development.

1.3.3 Policy recommendations in health sector

Policy guidelines

1. The immediate objective in policy planning should be giving transparency, strengthen capacity and to understand the appropriate framework to facilitate knowledge/technology transfer in the health sector.

2. The newly industrialized economies will have a key role to play over the medium term in promoting innovation as part of their economic development.

3. Focus on technology for which there is a demand from local companies and markets as this will motivate local companies to develop innovative projects to suit local needs and markets, and will generate spill over benefits that can be captured by the local economy.

4. Share knowledge about management of the public/ private research interface.

5. To optimize their domestic innovation systems, enhance sustainability, and realize maximum benefits from globalization, governments should:

    - Provide support for the healthy development of private sectors and implement a welcoming policy environment to leverage global partnerships;
    - Create funds for financing prototypes and proof of concept;
    - Finance translational research to promote the development of new drugs to consolidate the domestic industry and broaden the benefits to society.

6. Improve and strengthen the role of the domestic intellectual property system, which is integral to the efforts to promote learning from technology transfer and follow-on innovation.

7. Establish special trust funds to support the training of scientific and technical personnel.

8. In order to success in technological innovation ventures, the most important factor is the innovation itself. The innovation must meet end user expectation. It should be something practical and useful for many people. The research should be planned early to show that the technology is safe and effective.

9. University's research projects are not only about pharmaceutical products, there are also IT projects, social innovation projects, among others. There is a need to foster these activities through public financing.

2. PUBLICATION: SUCCESSFUL KNOWLEDGE TRANSFER CASES IN APEC ECONOMIES

Introduction

The APEC economies face specific challenges as a region and a way to address these in the best possible way is to increase the transfer of tangible and intellectual property, expertise, learning and skills between academia and the non-academic community between the APEC Economies. Knowledge Transfer (KT) is a term used to encompass a very broad range of activities to support mutually beneficial collaborations between universities, businesses, public sector and society. KT provides a significant driving force for enhancing economic growth and societal wellbeing. For academics, KT can be a way of gaining new perspectives on possible directions and approaches for research. This two-way exchange element of KT is at the heart of successful and sustainable collaboration.

The Knowledge Transfer best practices between APEC Economies, (13^{th} – 15^{th} June 2018, Lima city) aimed to create a platform for policy makers, scientists, academics and private sector representatives, to interact and share information and experiences in order to implement effective mechanisms to encourage Knowledge Transfer.

The project intended to foster the exchange of best practices among relevant stakeholders of the innovation ecosystems in APEC economies; targeting the knowledge transfer concept as a key factor to create value among the knowledge chain. As well to encourage collaboration of the implementation of policies related with Knowledge Transfer, through different experiences and models of APEC economies.

This project considers as a general understanding and as starting point, that Knowledge Transfer is the movement of knowledge (from the scientific and technological production) for the public benefit; in other words, the use of research and technological outcomes to improve practices, in order to implement initiatives and to tackle specific problems.

The APEC economies have developed their own models to encourage the exploitation of the scientific and technological outcomes, with the aim to generate added-value in products and services to solve social needs and to create new market opportunities. Through the implementation of a Knowledge Transfer network, the project aims to share through the analysis of (selected) APEC economies' models, best practices, experiences and strategic information, that will result in the benefit of regional cooperation.

The Report: Successful Knowledge Transfer Cases in APEC Economies, is a compilation of successful cases written by APEC representatives, whose attended the Workshop on Knowledge Transfer Best Practices. The report aims to share experiences in the knowledge transfer field in order to promote best practices in public policy. This experience shows us the efforts made by different actors to promote and increase the link between research outputs and industry needs.

Each report content an economic context and description of innovation system with the purpose to understand the frame in which technology transfer is carried out. In addition, each report describe the "successful story" to transfer the technology. Finally, a set of recommendations is given by the APEC representatives.

Successful Technology Transfer Cases Of APEC Economies

2.1 A new nanofiltration process to produce water

David Molina Concha
david.molina@corfo.cl

Technology Transfer Hub Executive

Economic Development Agency

Chile

Summary

This case is related to a technology developed in the engineering faculty of the University of Concepción for low cost water desalination. After 2010 earthquake, there was a water availability problem practically across the entire affected zone due to line breakages in the system. The government of India donated four inverse osmosis plants to the Arauco Municipality, however, the operations costs of these plants were not affordable for the municipality's budget and they had to shut them down. Due to this problem, Professor Rodrigo Bórquez developed a two stage nanofiltration process to produce water with adequate minerals levels, so it doesn't need to be re-mineralized and requiring low pressure levels. The intellectual property for this innovative process was patented and then licensed by the Technology Transfer Office of the University of Concepción to the company Alister Ingeniería y Construcción LTDA. Nowadays the company is transforming one of the four abandoned plants to start the production with the nanofiltration process and provide water to 375 families of a rural village.

Economic context

Chile is considered the most stable and prosperous economy in Latin America, leading in competitiveness, income per capita, globalization, economic freedom, and low perception of corruption. Although Chile has high economic inequality, as measured by the Gini index. In May 2010, Chile became the first South America economy to join the Organisation for Economic Co-operation and Development (OECD). Tax revenues, all together 20.2% of GDP in 2013, were the second lowest among the 34 OECD economies. Chile has an inequality-adjusted human development index of 0.661, compared to 0.662, 0.680 and 0.542 for neighboring Uruguay, Argentina and Brazil, respectively. In 2008, only 2.7% of the population lived on less than US $2 a day. The Global Competitiveness Report for 2009–2010 ranked Chile as being the 30th most competitive economy in the world and the first in Latin America, well above Brazil (56th), Mexico (60th), and Argentina which ranks 85th; it has since fallen out of the top 30. In the doing business index, created by the World Bank, listed Chile as 34th in the world as of 2014, 41st for 2015, and 48th as of 2016.

Innovation System

The Chilean innovation system has two main public innovation funding entities. The National Commission for Scientific and Technological Research (CONICYT by its Spanish initials) belongs to the Ministry of Education. CONICYT is the main fund specialize in science and technology and

the main financier of basic and applied research in Chile. Additionally, CONICYT have been promoted the creation of research centers and funded joint R&D projects.
The Economic Development Agency (CORFO by its Spanish initials) is the Chilean agency specialize in innovation belong to the Ministry of Economy. The main CORFO´s goal is to diversify and enhance the competitive through innovation. Its funding programs are oriented to dynamic startups, R&D projects of companies and creation of technological capabilities in R&D Centers and Universities.

Most of the R&D developed in Chile is executed by the Universities (38,5% of the R&D expenses in 2016) and financed by the government (66,1% in 2016), so CORFO has been creating and strengthening the Technology Transfer Offices (TTO) located in universities and R&D Centers. The objective is the creation of capabilities in technology transfer and commercialization.
In 2016 CORFO started the implementation of a new technology transfer model for Chile, On Campus / Off Campus Model, where at the On campus level the TTO will keep the direct relationship with researchers, fostering a innovation culture in the institution and promoting the engagement with the local industry through R&D projects and technologies. The Off campus level has resources and capabilities to manage and successfully commercialize technologies in international markets with high standards. To be sustainable, the off-campus needs critical mass of R&D results, therefore CORFO created 3 technology transfer Hubs to manage high potential technologies in three main areas, Industry & Energy, Health and Agriculture.

The main technology transfer mechanism in Chile are research contracts and licensing. In 2016 the TTO's (sample of 29 institutions) reported 144 R&D contracts and 43 Licensing agreements. In the last three years both mechanisms have been increasing notoriously, since CORFO started to execute a set of programs to fund R&D projects to companies and foster cooperation between academia and industry based in technological services, joint projects and technology transfer.

Another relevant mecghanism of technology transfer in the innovation system is Spin-off creation. Chile has support programs for all the different stages of a startup (Startup Chile, Seed, Scale-up) as well as a community of incubators, accelerators and Venture Capitals. Outputs show that universities and R&D Centers creates an average of 7 spin –off per year (sample of 29 institutions), which is acceptable considering the amount of expenditure in R&D of the economy.

Successful story

After the earthquake of 2010, CORFO launched a call to fund projects associated with reconstruction efforts. Rodrigo Borquez, professor of the faculty of engineering of the University of Concepción, and resident of the affected zone, realized that one of the substantial problems after the earthquake (27 February 2010) was water availability. This didn't happen only in areas with prior water scarcity, but practically across the entire affected zone due to line breakages in the system.

Proffesor Borquez had been working in the area of membrane technology for some time, so he decided to develop an application for water production and apply to CORFO's funds. Globally, the most widely used technology for water desalination is inverse osmosis, a process performed at over 15,000 plants. Furthermore, antoher technology for desalination is based on evaporation system. While all of these options are viable, there is one important limiting factor, particularly for economies or communities with fewer resources: profitability.

During the course of his research, in fact, Proffesor Bórquez discovered that four inverse osmosis plants had been donated after the earthquake to the Arauco Municipality by the government of India. Nevertheless, running these plants impacted the municipality's budget to such a degree that they were impossible to use, resulting in the near abandonment of the plants. Due to this, the main goal of the project was to have low operations costs of the plant, therefore the research team concluded that nanofiltration had to be completed in two stages. In the first stage, the filtered water still retains 5% sodium chloride, which would be fine for industrial uses but not as drinking water. So, this intermediate state is passed through a second filter to obtain a product that complies with Chilean regulations for drinking water, without needing remineralization. Another important comparative advantage is that the developed process requires relatively lower pressure levels, meaning that the energy needed for desalination is easily reduced by 30%. Those results were reported to the Technology Transfer Office (TTO) through the invention disclosure form to activate the evaluation of the technology's potential. CORFO promoted the adoption of IP regulations and innovation management process through TTO support program, to make sure that any institution has a framework to evaluate and prioritize technologies with high potential, form a portfolio and transfer technologies to external entities.

The TTO and the Industrial Property Unit (UPI) of the University saw the potential of the technology and proceed to apply for a patent in Chile (2013). The TTO started to contact potential licensee and found the first big barrier, companies wanted to validate and certify the results in a industrial environment, therefore it was necessary to build a pilot plant. In 2014 the University applied for CORFO funds to test the technology and obtain specific know how in the industrial application of the water treatment process. The university did not obtain the funds and choose not to present a PCT application, protecting the invention only in Chile. It wasn't a good policy, because presenting a PCT is not expensive and can give a total 30 months to obtain relevant results and a licensee, if the TTO is not able to succeed in that time frame, then the application should be abandoned and avoid futher expenditure.

In 2014, a company was interested in the results of the failed project presented to CORFO, so in 2015 the TTO changed the strategy and negotiated with Alister Ingeniería Construcción Ltda. As part of agreement, the company presented a project to CORFO founds to validate the technology. In the agreement there was a license option, which will be executed if the results of the test were satisfactory. Usually technologies validation agreements occurs under a NDA (Non-Disclosure Agreement) without making explicit the license option, therefore, I consider a good mechanism to clearly state in the validation contract the willing of both part to sign a license if the results are satisfactory.

Now, Alister Ingeniería y Construcción LTDA is charged with commercialization, they won a public call for bids for the construction of a water treatment plant in Arauco and they are transforming one of the four abandoned plants to start the production with the nanofiltration process and provide water to 375 families of a rural village.

Recommendations

- Establish a robust IP regulation in the institution and promote innovation culture, so researchers know where to report their inventions results and work with the TTO.
- Design an efficient patent application policy, considering the available budget of the institution. This policy should be known by every researcher when he report his or her invention.
- When a company wants to test a technology, negotiate a license option with specific criteria according to company expectations.
- Involve researcher with promising results with industry actors, so they can define which features of their technology are relevant and desirable conditions to test them.
- Always consider budget for IP protection in public founded projects.
- Take advantage of the 30 months of PCT to perform commercialization efforts in most attractive markets. If a licensee is found, try to pay the patent cost with upfront fees of the deal.
- Understand the commercial plan of the company for the technology, so you can provide the necessary IP rights, territories and applications. With a clear plan it is easier to establish milestones in the licensing agreement and monitor the correct use of the technology.

2.2 CAPPS: A software to support the production process decision–making

Etienne Choupay
echoupay@economia.cl

Projects and Technology Transfer Coordinator

Innovation Division
Ministry of Economic, Development, and Tourism

Chile

Summary

The Company DEMAFRONT finds its origins at an entrepreneurial project developed by researchers at the Pontifical Catholic University of Valparaiso (PCUV's) School of Industrial Engineering. Funds were obtained from the research development program FONDEF-CONICYT and CORFO as well as its technical and commercial validation.

The entrepreneurial project consisted in the creation of the software CAPPS; a support system in the decision making regarding the planning and programming of the production of products. It is capable of proposing plans and programs of efficient and operationally feasible production in a minimum time of response. It utilizes highly sophisticated and flexible models of optimization internally which can be configured to suit diverse productive systems.

Currently the software is being commercialized and acquired by companies such as EMBONOR, VITAL, and Concha y Toro.

The interest generated in the productive sector and the demand for the software motivated its developers to start up a spin-off Company. Its formation stages were supported by the University's business incubator Chrysalis which contributed with complementary resources to fortify its commercialization strategy.

Economic context

Chile is considered the most stable and prosperous economy in Latin America, leading in competitiveness, income per capita, globalization, economic freedom, and low perception of corruption. Although Chile has high economic inequality, as measured by the Gini index. In May 2010, Chile became the first South America economy to join the Organisation for Economic Co-operation and Development (OECD). Tax revenues, all together 20.2% of GDP in 2013, were the second lowest among the 34 OECD economies. Chile has an inequality-adjusted human development index of 0.661, compared to 0.662, 0.680 and 0.542 for neighboring Uruguay, Argentina and Brazil, respectively. In 2008, only 2.7% of the population lived on less than US $2 a day. The Global Competitiveness Report for 2009–2010 ranked Chile as being the 30th most competitive economy in the world and the first in Latin America, well above Brazil (56th), Mexico (60th), and Argentina which ranks 85th; it has since fallen out of the top 30. In the doing business index, created by the World Bank, listed Chile as 34th in the world as of 2014, 41st for 2015, and 48th as of 2016.

Innovation system

The current ecosystem of technology transfer in Chile comprises an on campus-off campus model which supports transfer and licensing offices (OTL) with public funds and hubs of technology transfer whose history is described as follows:

In 2011, CORFO launched the first call for “Creation and Strengthening of Transfer and Licensing Offices (TLO)” addressed to universities and technological centers. The call supported 18 projects.

Consequently, all the OTLs developed new intellectual policies, procedures, regulations, and new information systems, increased their contact networks, formed capacities, compared to their international peers (benchmarking) and developed a roadmap with defined objectives.

Afterwards, during 2014, CORFO announced a second call for the strengthening of OTLs. This call aimed to support the consolidation and positioning of each and every of the mentioned entities. This was expected to promote the briefcase of initiatives with marketing potential; increasing significantly the number of disclosures, research and development contracts; licenses, consultancies and collaborative research with companies and other research-development-innovation entities. 15 OTLs from universities and a technological center were funded by this second call.

Lastly -and with the aim to create new OTLs and consolidate the existing ones- in 2015 CORFO set forth the third call. CORFO proposed to initiate a new stage in the programs supporting technology transfer with a specialization model of on campus-off campus functions. This model recognizes the necessity to continue strengthening the capacities of commercialization and transfer of the offices. Additionally, it acknowledges the need to move forward into developing more specialized competencies in order to improve the probabilities of success in the commercialization of technologies with global potential.

The consolidation of the existing OTLs tackles the on campus part of the model. The on campus model’s main aim consists in supporting the existing OTLs so as to transfer knowledge and create businesses with technological base. The businesses are meant to be created from the results of the research and development activities.

In order to address the off campus stage, CORFO announced the program “Technology transfer Hubs” in 2015. This program aims to increase the amount of technological businesses –and their projection- based on the results of research and development generated by universities and research centers; thus augmenting the productivity and diversification of the Chilean economy.
These hubs are associative organizations, which gather a great number of universities, technological centers, companies, unions, angel investors’ networks, investment funds of venture capital, among others. In this framework, 3 projects were granted in a range of regions and focused primarily on agriculture, health, industrial production, technology and energy.

Successful story

CAPPS is a copyrighted software in accordance to the Chilean copyright law. Its rights belong to its holder and authors as well as its moral and property rights.
The University grants the Company the exclusive right of use of the software CAPPS and its latest improvements provided that the current contract is standing. Worldwide exclusivity will be given through the company Demafront SpA which holds exclusivity and commercializes the technology to the audience.
On this occasion, the university chose not to have a corporative participation in the company, but to grant the license of the developed technology. However, the PCUV’s researchers do have a social participation in the entrepreneurial project.
Notwithstanding the foregoing, the university has a right of option of property in the business of 7%. This matter was considered when negotiating the licensing contract between the company ant the PCUV. The context in which this entrepreneurial project was inserted includes consultancy

companies, financial advice companies and companies supporting lines of business when they refer to data processing and activities related to database management- highly connected to the trends in data mining.

The Office was key in the determination of the business's future and the celebration of the licensing contract. The OTL was also key in the definition of the terms of the license contract as well as in supporting the researchers in the formation of their company.

Recommendations

Some recommendations to promote incentives to develop technology transfer:

- Researchers do not feel motivated to develop technology transfer activities mainly due to the preference in supporting basic research and the generation of publications in indexed journals. It is necessary that public institutions contribute to foster a technology transfer culture in resources supplied by the Ministry of Education and the universities.
- Overall, the public programs do not consider the indicators associated with contract research, know-how contracts or mobility of human resources despite being important mechanisms that support the strengthening of the science-industry link.
- Furthermore, the main indicator of technology transfer used is the patent (applicated and obtained). This has provoked that in many cases it is only patenting for the sake of patenting. The reason for this might be that a patent application is easier to measure and accomplish in a short period than other metrics. However, few patents are successfully licensed and granted with monetary benefits.
- Research institutions –by means of their technology management units- rarely evaluate rigorously the best transfer strategy. Patenting is not always the best alternative; it depends on factors such as the level of inventiveness and the maturity of the technology and of specific logics of each productive sector. Similarly, according to the potential market of technology, a patent obtained in Chile is not sufficient. A strategy of foreing patenting might be necessary to run.
- Although they do not qualify strictly as technology transfer mechanisms, research by contract, know-how contracts and the human resources mobility between the academy and the industry contribute to: (i) the generation and continuity of strong trust bonds between institutions that do research and development and the productive sector; (ii) make research institutions aware of the technological challenges of each industry and company; and (iii) the financial sustainability of the institutions that do research and development.
- In this regard, this kind of initiatives are factors that facilitate technology transfer and, in a long term, can have an impact in the increase of innovation based on scientific and technological knowledge in the economy.
- The creation of spin-offs from the knowledge generated by research institutions have great advantages as a technology transfer mechanism. However, it has not been installed as a strategic objective in the policies that promote the transfer

2.3 The use of fertilizer – water irrigiation technology

Zhu Junqiao
674720645@qq.com

Manager of Scientific Research Institute

Scientific Research Institute
Zhejiang Normal University

China

Summary

The team of researchers studying blueberries is come from Zhejiang Normal University of China. After finding the blueberries' quality and yield are both not high in the Zhejiang province, they began to research the cultivation and management method. In the end, they used soilless cultivation and fertilizer-water irrigation technology to successfully cultivate high-quality blueberries which were suitable for local cultivation. The fruits have precocious and high-quality features.

After that, many enterprises came and discussed the cooperation with them. knowledge transfer was mainly conducted through technical consulting, technical services, and derivative companies. Now there are more than 1,000 acres of demonstration bases have been established in Jinhua, Quzhou, Huzhou, and other places in Zhejiang province, with a yield of about 1,000 kilograms per acre, and an output value of about 50,000 yuan per acre. Significant social and economic benefits have been achieved.

Economic context

China's university technology transfer has undergone a process of gradual improvement and development. Before the reform and opening up, China had established its research system and production system mainly in accordance with the planned economy model. The university did not have substantive technology transfer activities. After the reform and opening up, the central government proposed that "economic construction must rely on science and technology, and science and technology must be oriented toward economic development." After that, universities based on science and technology were oriented to work more closely with industries. As a consequence, university technology transfer activities gradually enter the cooperation stage of production, education and research.

In recent years, the Chinese government has established a channel to integrate science and technology with economy, promoted popular entrepreneurship and innovation, encouraged research and development institutions, institutions of higher education, and other innovative entities scientific and technological personnel to transfer scientific and technological achievements, and promote economic and efficiency upgrading. "The People's Republic of China to Promote the Conversion of Scientific and Technological Achievements", "Zhejiang Province Promotes the Transformation of Scientific and Technological Achievements", "Notice of Zhejiang Normal University on Printing and Distributing Administrative Measures for the Transformation of Scientific and Technological Achievements¨ and other documents have been introduced.
So under the external system of new technology transfer, universities play an important role in the construction of technology transfer systems and it is of great significance to vigorously promote technology transfer.

Innovation system

In order to further promote the transformation of scientific and technological achievements in Zhejiang Province, Zhejiang Province put forward the “Opinions on Further Strengthening the Construction of Technical Market System to Promote Industrialization of Scientific and Technological Achievements”. It promote the transformation and transfer of scientific and technological achievements, enhance the development of the “Internet +” Zhejiang science and technology market, speed up the construction of the Zhejiang Intellectual Property Exchange Center, create a first-class scientific and technological achievement trading center, and cultivate social technology transfer agencies.

Now we have formed a supply-demand, intermediary, and market-operating body that combines the four parties to display, trade, service, share, and exchange the “five in one,” a unified, unified technology market system that integrates online and offline, and implements provincial universities and research institutes. Relying on the technology market, it will publish scientific research results.

Zhejiang Province continues to speed up the construction of offline entity technology markets that complement the functions of online technology markets, such as the construction of economy and sub economies high-tech zones, attracting universities, research institutes, technology transfer agencies, technical intermediary agencies, and dragon skull enterprises to enter and launch Various services and services for the trading of technological achievements; introduction of financial, capital, talent, industry and other service agencies to provide supporting services for the transfer, transformation and industrialization of scientific and technological achievements; academic forums, technical lectures, seminars, expert help and other activities , to strengthen the exchange and docking between production, education and research.

The channels of university knowledge transfer have the characteristics of diversity, complexity, and risk. University teaching and research staff create most of the research results focused on technology transfer charts or innovation and commercialization offices. The channels for knowledge transfer include academic papers, seminars and consulting companies.

In terms of the transfer of agricultural technology, the state supports and encourages scientists to provide non-profit technical guidance and promotion to farmers. For example, as teachers of science and technology, college teachers go deep into the camp to provide farmers with blueberry planting technical guidance and services.

Successful story

Blueberries belong to the family Vaccinium spp. of the family Ericaceae. Perennial deciduous or semi-deciduous species are mostly shrubs and less are small trees. The roots of blueberry must be fine, fibrous, and have no root hairs. They need to be symbiotic with the fungus to absorb water and nutrients in a mycorrhizal manner, showing resistance to waterlogging, poor drought tolerance, and stringent soil conditions. The pH of the soil needs to be 4.0-5.5, the organic matter content is 8% - 12% (minim “Zhejiang Key Laboratory of Characteristic Economic Plant Biotechnology Research” has introduced 62 Bei Gao Cong and Nan Gao Cong blueberry cultivars at home and abroad for experiment and research, and has selected 'Shi Da' and “Ai Mei Rui” suitable for cultivation in our province. Giant excellent 'and other excellent fresh food species

At present, blueberry cultivation in Zhejiang province adopts the method of land planting. This conventional cultivation method has the advantage of low construction cost. However, its defects are also very prominent, mainly in: 1) Weed control is difficult. Due to abundant rainfall, mild climate, and strong weed growth in our province, the cost of management for weed control in conventional cultivation is high. Blueberry is a shallow rooted plant. The use of herbicides has a certain degree of damage to the tree body; and the use of herbicides also causes product and environmental pollution to a certain extent. Therefore, artificial weeding should be used for blueberry cultivation, and the average labor cost for weed control is as high as 2000 yuan/year or more per mu. 2) Spring damage occurs from time to time. Some blueberry orchards have strong soil moisture, heavy rainfall in the spring, and serious damage to the leeches, causing the blueberry roots to grow long and even rot. 3) Severe hot summer drought. The blueberry garden established in the hills and mountains is vulnerable to the high temperature and drought in summer. The leaves are scorched and the plants die. The hilly and mountainous regions adopt land-planting methods, which require a large amount of water for irrigation and increase production costs.

Different varieties of drought resistance, heat resistance, growth and development characteristics and fruit quality were compared and analyzed. According to the characteristics of different varieties, establishment of gardens, pruning, load control, soil and fertilizer water management, pest control and other supporting cultivation techniques System, give full play to our province's fresh blueberry early maturity, high-quality features, improve market competitiveness (um not less than 5%), the soil is loose and airy, and it is humid but not watery.The results of the laboratory attracted a large number of blueberry planting companies and they came to discuss cooperation.

However, there are many difficulties in the technological transfer of agricultural products. 1) Most of the agricultural products are carried out in Daejeon, which makes the confidentiality of the technology poor, and the secrecy costs of seedlings are also high. 2) Demonstration of agricultural technology achievements is poor and influenced by the natural environment. 3) The success of agricultural technology applications depends not only on the risks and market risks of the technology itself, but also on the nature of the natural reproduction of the agricultural products, so the natural risk is also a factor that cannot be ignored.

Therefore, in large agricultural scattered areas, scientific research personnel mainly provide free technical guidance and services to farmers. However, due to the large differences in the overall quality of farmers, and the different efficiency in mastering technologies and management methods, the harvests obtained are difficult to be guaranteed and directly affected the transfer of scientific research results. Therefore, in the transfer of agricultural products, it is easier to achieve in the enterprise, but in addition to the limited transfer of results, it is not easy to get high returns from the innovators of the enterprise. In the face of these problems, the lab finally chose to cooperate with the enterprise to derive the new start-up companies have formed a cooperation base of production, learning and research. At the same time, they also cooperated with the local government to establish cooperation between the school and the campus, and provided services such as technical commissioners, blueberry training courses, and technical guidance. The common cultivation and cultivation of blueberries is beneficial to the scientific management of the laboratory and the application of technology. On the other hand, it also ensures the effective transfer of scientific and technological achievements.

In addition, the laboratory team members also cooperated with a number of companies in various regions to form a demonstration base, continuously researched and promoted new cultivation methods, and provided free guidance and services to farmers in the form of science and technology commissioners and contribute to the local community.

Now there are more than 1,000 acres of demonstration bases have been established in Jinhua, Quzhou, Huzhou, and other places in Zhejiang province, with a yield of about 1,000 kilograms per acre, and an output value of about 50,000 yuan per acre. Significant social and economic benefits have been achieved.

Recommendations

In China, the promotion of agricultural science and technology is still a social welfare undertaking. Colleagues are also a large and complex system project. The new model of science and technology popularization and technology transfer in universities is still at an exploratory stage and needs to be continuously revised and improved in practice. These require the broad participation of governments, universities, grass-roots agricultural departments, and enterprises and their complementary advantages to create a good external environment to ensure their normal operations.

- To establish efficient agricultural technology transfer and promotion operating mechanism. This is conducive to the promotion and transformation of university technological achievements, promoting the development of agricultural modernization, and promoting the construction of local regional economies. It also enables the university's discipline construction and personnel training to be closely integrated with current agricultural development.

- Establish an efficient financial support system. Agriculture is a weak industry that bears the dual risks of nature and the market. The government's strong financial support is an important support for the formation and transformation of agricultural scientific and technological achievements and directly affects the development of agricultural economy.
- Pay attention to the construction of agricultural technicians. Fully consider the demand for personnel training in the regional economy and new rural construction, and rationally adjust personnel training plans to better serve the construction of new rural areas and regional economic development.

2.4 The introduction of MR 263 paddy seed

Zakwan Bin Azahari
zakwan@moa.gov.my

Under Secretary of Human Resource Management Division
Ministry of Agriculture & Agro-Based Industry

Malaysia

Summary

Paddy Farmers in Malaysia has been using the same paddy breed variety MR 219 for more than 20 seasons. This situation may threaten the industry in the event of a disease or pest attack. The resistance to disease (karah) has decreased. One or two new varieties are very critical to be introduced as complementary to these weaknesses as well as a step to diversify the planted varieties to help prevent pest infestation.

Malaysian Agricultural Research and Development Institute (MARDI), which is one of agency under Ministry of Agriculture and Agro-based Industry has introduced MR 263 paddy seed varieties in 2010 through their years of research to replace the previous variety.

The advantages of MR 263 variety are:

- Has a maturity of about 97-104 days after sowing, which is about 8 days earlier than the previous variety;
- Has a better resistance to particular paddy disease.
- The rice yield on the MR 263 varieties is 10% better than MR 219; and
- Is suitable for planting in all irrigated areas of rice cultivation as well as less fertile area than MR 219

Economic context

This Technology transfer case occurred in the Agriculture sector in Malaysia. The technology was developed by MARDI which is one of the agency under Ministry of Agriculture and Agro-based Industry, established with the primary objective of generating and promoting new technologies, fair and efficient for the advancement of the food industry, agriculture, and agro-based industries in Malaysia.

Rice is the second most important crop in the world after wheat, with Asia being the largest producer and consumer. The Agrofood Policy of Malaysia, 2011-2020 has highlighted that local rice should be increased to ensure the economy’s demand in future. More than half of the MOA’s development budget allocation is focus on the paddy infrastructure and incentives related to paddy and rice.

Rice production in Malaysia has hit 72% of the economy's self-sufficiency level (SSL), compared with the target of 80%. The productivity in rice production should be increased to meet the 80% target, noting that production had increased from 1.9 million tonnes in 1990 to 3.5 million tonnes last year.

In 2011, total paddy planted areas in Peninsular Malaysia was 517,586 hectares, and in 2014 the area planted dropped to 514,381 hectares. Based on unofficial data, it was estimated the area planted further dropped to 510,000 hectares in 2016. Overall paddy yield in Malaysia has increased from 3,788 kg/Ha in 2005 to 4,527 kg/Ha in 2014.

Paddy and rice considered one of the most important crops under Agriculture because of:

- it has to protect the income of around 172,230 paddy farmers,
- food security policy for Malaysia
- staple food for the majority of the Malaysian

In 2016, the production volume of rice in Malaysia total approximately 1.77 million metric tons with 960,000 metric tons imported to accommodate the requirements of 80% of 30.6 million Malaysian population.

Innovation system

The Ministry of Higher Education Malaysia (MOHE) has developed a policy called Knowledge Transfer Program (KTP). KTP is a initiative under RMK-10 to strengthen the network and collaboration between industrya and the academia.

KTP's main objectives are:

- To ease the transfer of expertise and research results through innovative projects which are handled together by academic staffs and business partners from industries and target communities
- To provide training based on industry to graduates to increase knowledge and experience, entrepreneurship skills, and graduate marketability

Ministry of Agriculture and Agro-Based Industry (MOA), has its own research center name Malaysian Agricultural Research and Development Institute (MARDI) that do most of the research and development of agriculture product. However, there are collaborations between MOA and local Universities on problem-solving related to agriculture issues.

Universities use the model of implementation established in the KTP. The model takes into consideration three parties: academia, interns at graduate/postgraduate level, and Industry/Community.MARDI use a slight different model of implementation with different parties involved.

In order to achieve their economic objectives, MOA must carefully consider the appropriate mechanism of transfer in their strategic decision, especially the type of entry modes. The mechanisms used are closely related to the type of technology (tacit, explicit or complex), the age of technology, level of protectiveness, contextual factors and learning capabilities of the technology recipients.

In this new high yield paddy innovation technology transfer case, MOA used licensing and joint ventures mechanism. These transfer channels are regarded as the most efficient and relevant transfer channels undertaken by MOA when transferring their technology to the farmers where the technology flows through the market-mediated mechanism with some form of formal transaction underlies the technology movement.

Once MARDI has successfully produce a new high yields breed, it has to be presented in the Ministry Technical Committee that comprised of Secretary General, paddy expert from the rice industry, Ministry of Finance representatives and Seed producers' representatives.

After the committee is convinced about the profitability of the new research, MARDI would identify the several companies that has the capability to produce the seeds according to the specification of the MR 263 with a contractual agreement. This companies will get the authority to act as producer and sales agent to farmers.

To ensure the company would produce seeds that comply to the specification, another agency under MOA which is Department of Agriculture (DOA) representatives would do the routine quality inspection at manufacturer site and at plant area.

Successful story

This technology transfer involved five (5) different entities; MARDI, DOA, IADA, Technical Committee and Company/Agents.

A. Malaysian Agricultural Research and Development Institute (MARDI) is an Agro-food innovation powerhouse that has a mission of creating agricultural technology for societal wellbeing. This is the Agency that do the research of MR263.

B. Department of Agriculture (DOA) – has two main function:

   i. Provide agricultural extension and agricultural development services through technology transfer of good agricultural practices based on the chain value to improve the income, production of high quality crops, adequate and safe for consumption; and

   ii. Regulate & enforce Agricultural Acts which protect the agriculture industry, food safety and quality from the threat of pests and foreign diseases and facilitate International Agricultural Trade.

C. Integrated Agriculture Development Agency (IADA) which is a statutory body assigned by MOA as a representative body for regulations and assistantship to the paddy farmers. The obligation of IADA is to manage the whole plantation of paddy, such as when and how to harvest, and providing the necessary and sufficient mechanism for the harvest of paddy. MOA has set up ten IADA offices according to several regions in Malaysia which was decided being located at the major paddy area in Malaysia.

D. Technical Committee -a group of stakeholders that approve the new seeds for paddy farmers in Malaysia

E. Company/Agent – Seeds manufacturer and seller to farmers.

MARDI is the agency that play the biggest role in this mechanism by doing the research of paddy seeds and other development effort related to paddy industry.
Since land is a critical issue, the increase in production is planned not by opening new planting areas. Other ways such as the use of marginal land and new technology will be explored. One of the latest variety is MR 263 which is proven could increase the yield by up to 9% is significant to be introduced to the farmers.
However, it’s always a big task in this Innovation diffusion with stakeholders already complacent with the current paddy variety.
Even though MARDI has strengthening the delivery system technology as part of a comprehensive approach to innovation implemented by the establishment of a test-bed and technology incubator since 2005 as a component of development programs, still many other factors that contribute to the barriers of the technology being smoothly transfer to farmers. The barriers included:

- Firstly, the different outcome on the pilot test. MARDI was able to come out with the high yield objective during the test bed process. However, it has various outcome in the pilot test in different location. After several analysis and observation, finding stated that many other factors contributed to this result including the different level of infrastructure, the different level of land fertility, the different standard of operating procedure in management, the different fertilizer used and also the different weather also play a slight role to the outcome.

- Secondly, the seed producer produces a different standard of seed. Supposedly manufacturers and distributors from the private sector should also play a primary role in disseminating knowledge about new technologies and products related to paddy industry. If they were unable to perform this duty, it would give a negative impression to the government efforts to enhance rice production.
  MARDI has collaborated with DOA, and has come out with a specific Standard Operating Procedure (SOP) of delivering the technology to the farmers. DOA play the inspection and enforcement role at the manufactures facilities and premises as well as at farmers land. Any licensed seed manufacturer that do not follow the SOP would have the risk of the licensed being revoke.

- Thirdly, the majority of the paddy farmers are complacent with the previous/current seeds and they reluctant to use the new high yields paddy seeds that is proven more productive and stronger. Most of the farmers reluctant to take a risk investing in the new innovation.
  In this situation, Integrated Agriculture Development Agency (IADA) officer has played the role of the extension. The officers need to be fully utilized to disseminate knowledge and further strengthened as their function is crucial especially in this transfer of technology case. Extension services focus more on raising awareness and providing knowledge to the farmers on the choices they have and keeping themselves abreast with newly developed technologies.

One of the most effective strategies that MOA did and keep on doing is the constructive communications between technology developers and potential adopters. This strategy is essential to examine market prospects. A coordinated effort between the government extension officers and liaison officers from the manufacturing companies in providing extension services through communications, constant joint trainings and preparation of extension materials would be very beneficial.

<u>Among the policy/mechanisms implemented</u>

Rice is a staple food and a strategic industry in Malaysia. Due to its importance, the rice industry has received special attention from the government. Besides its social-economic-political significance, such as poverty eradication, rice was placed as the most important food crop for ensuring the economy's food security. So among the policy or mechanism to optimize the production cost and remain the farmers' interest to plant paddy, several system and policy were introduced which are:

a. Soil profiling system

This system is about soil fertility management and is developed to analyses the soil at each of the paddy land at the beginning of the planting season. The result would be helpful for the farmers to use an adequate fertilizer rather than simply distribute the same amount of fertilizer at all paddy plant. The idea is, a healthy soil need less fertilizer.

b. Rice Subsidy Program

The Malaysian government aims to protect the interest of local farmers as well as low income earners via its Rice Subsidy Programme. One of the main reasons as to why the government should continue subsidizing rice is to increase the self-sufficiency level of the local rice market. According to BERNAS (the only licensed company to import rice), the firm imports around 30% to 40% of Malaysia's domestic rice demand to fulfil the rice requirement. This shows that the local rice market's sufficiency level is only around 60% to 70%. Therefore, in order for Malaysia to achieve an 80% to 100% sufficiency level, rice production in the economy must increase.

With the introduction of subsidy by the government, local rice farmers collect better income for every tons of paddy that they harvested. This indirectly lowers the cost of paddy production for the farmers.

Besides being beneficial to the producers, the continuation of the Rice Subsidy Programme by the government of Malaysia will also help lower the cost of living for the low-income earners. While the subsidies provided by the government are distributed to the rice producers only, it has a direct effect on consumers as well.

Most of the farmers achieve low productivity that is below the average of 3.8 tonnes per hectare. The average farm size is low at 2.5ha, resulting in low income for farmers. On average, paddy farmers earn RM1, 400 per month compared with RM1, 860 per month by fruit farmers.

On top of that, the reduced prices of rice due to subsidy will also protect local rice companies against competition from imported foreign rice. Consumers will be more attracted by the cheaper prices of local rice, which will result in local rice being the preferred choice over the others.

In short, to ensure the sustainability of the rice industry, the reduction of subsidies should be compensated with a very large increase in growth-driven supports, such as development of all inputs, enhancement of research and development for better yield, machinery, value-added, logistics and infrastructure, bigger institutional support for farmers and a more competitive paddy and rice market (input and output).

Recommendations

This theme is that varying types of economic settings (benefiting poor groups in different ways) relate to particular forms of institutions and processes of governance, and consequently have an impact on the nature of poverty.

We could differentiate it into two different category, the first is an economic setting that is constituted by local economies; the second, catering mostly to richer groups, is that which is constituted by corporate economies.

The former cases have many steps and complicated to manage the circulation of seeds from agents to hundreds thousands of farmers and the process selling rice to Malaysian population.
In fact, the paddy and rice industry needs is high productivity and low cost of production. High productivity is a function of technology transfer through massive extension programs.

To ensure the sustainability of the rice industry, the reduction of subsidies should be compensated with a very large increase in growth-driven supports, such as development of all inputs, enhancement of research and development for better yield, machinery, value-added, logistics and infrastructure, bigger institutional support for farmers and a more competitive paddy and rice market (input and output).

It is possible to replicate the same case to another economic setting that anchored by foreing company. The corporate company with huge capital could have collaborate with government to set up a huge scale of paddy production.

2.5 The case of M3DICINE Stethee TM

Aini Suzana Ariffin
ainisuzana@utm.my

Head of Projects on Entreprenurship and Technology Commercialization

Perdana School of Science Technology Innovation Policy
University Technology Malaysia

Malaysia

Summary

Particularly in the Health Sector - one of the current successful technological innovation developed by the Ministry of Health (MOH) and it collaborators was the M3DICINE Stethee™, the world's first Artificial Intelligence (AI) enabled stethoscope system evolved from the traditional stethoscope which has not been updated in the last 200 years. The Stethee system includes three core products: the Stethee Pro, Stethee Vet and Stethee Edu. The Stethee™ Pro 1 has received clearance from the US Food and Drug Administration (USFDA).

The Stethee is designed to work as easily as a traditional stethoscope, allowing users to listen to heart and lung sounds with sophisticated amplification and filtering technology. The recordings can then be transmitted to a smart device (i.e. any smartphone or a tablet) via Bluetooth technology, and analyzed to build a personal biometric signature for each patient, and detect the presence of heart or lung diseases.

Artificial Intelligence and Data Analytics (AIDA), the technology platform behind the Stethee AI engine, also automatically tags geo-location and aggregate environmental data (temperature, humidity, pollen count, pollutant index) for analysis by healthcare professionals. Aida analyses this data (which is encrypted and anonymized) and is able to provide doctors, vets and healthcare professionals with quantitative clinically actionable data.

Economic context

Based on the above example the technology transfer took place as a result of strategic partnerships between MOH Malaysia, Malaysian Investment Development Authority (MIDA), CREST and M3DICINE which was facilitated by the Telemedicine Development Group (TDG). TDG is co-chaired by the DG of Health and Chairman of the Malaysian Communications & Multimedia Commission (MCMC). It provides a platform for digital innovation, digital health services ecosystem and collaborative partnerships which will put Malaysia on the world map as a medical device hub. Stethee was invented by Dr Nayyar Hussain from Brisbane, Australia who set up M3DICINE. He works with Texas A&M University, MIT and the Mayo Clinic in developing Stethee.

Malaysia was chosen as the production hub of Stethee after careful evaluation of few other economies. M3DICINE Technology Sdn Bhd, the Malaysian unit of M3DICINE was set up for this purpose. Other than technology transfer, this venture would increase export earnings for Malaysia, provide business and job opportunities for the economy. Stethee is a high technology combining AI, internet of things (IOT) technology and medical device, which aligns well with the general policy in embracing the fourth industrial revolution (Industry 4.0). It comes under the electrical & electronics (E&E) industry, which is the leading sector in Malaysia's manufacturing sector, contributing significantly to the economy's exports (36.6%) and employment (25.3%) in 2016.

Based on this collaboration, more high impact medical technology products can be innovated and produced and enhanced further the E&E and medical device sector.

At the same time Malaysia Government intervention, do facilitate the enhancement technology transfer and commercialization efforts in other industries. For example, the Ministry of Science, Technology & Innovation (MOSTI) has initiated The Malaysia Commercialization Year (MCY) a platform to enhance the awareness of stakeholders and the public on the importance and potential of research and development, commercialization and innovation (R&D&C&I) in increasing the income. In 2017 some of 130 out of the 150 potential products and technologies from various industries have been commercialized. Subsequently to facilitate market penetration of local R&D products, 350 technopreneurs had signed up for capacity building and business matching programs carried out with strategic partners locally such as Malaysian Technology Development Corporation (MTDC), Technology Park Malaysia (TPM), Cradle Fund Sdn Bhd, 1MET, Teraju, Magic, SME Corp and PlatComm Ventures.

Innovation system

The technology transfer mechanisms in health industries may include general knowledge dissemination, university/institute-industry relationships (UIRs), and commercialization activities. General Knowledge Dissemination - Scientist or innovators routinely communicate their research findings to the scientific community and to the general public either through publication in scientific journals, presentation at scientific meetings/conference or press conference. This is usually done following completion of a research. In the health industry, there are certain regulations that have to be followed either for pharmaceuticals or medical devices for market entry. For pharmaceuticals, usually clinical data from Phase III clinical trial is required before a drug can be registered. As for medical device, clinical data requirement will depend on the risk imposed by the device.

University/Institute – industry relationships (UIRs) – UIRs is increasing with higher impact research being conducted. It can work be either, clinicians/researchers being involved in industry sponsored research or industry works with university/researchers to commercialize their products. Government related agencies like Bio economy Corporation and Malaysia Industry Development Authority plays an important role in technology transfer, where they identify potential technologies, including those related to health and bring them to Malaysia. At the same time, they also help to identify local partner.

Commercialization activities – this is increasingly being encouraged by the government where agencies such as the Malaysian Technology Development Corporation (MTDC), Technology Park Malaysia (TPM), National Innovation Agency Malaysia were set up and every Ministry is required to set up Value Innovation Centre (VIC). Ministry of Health has set up VIC to catalyze innovation in health care and facilitate commercialization.

Horizon Scanning also known as Early Awareness and Alert System or Environmental Scanning is conducted in Ministry of Health Malaysia to systematically identify emerging health technologies that may have potential impact to health and the health care system and inform the policy/decision makers. This is to enable long-term planning and preparation in adopting the technology being done to facilitate technology transfer.

For example innovation system adopted in Pharmaceutical industry. This industry is constantly looking for reducing cost of drug discovery and development.
Technology transfer provides an opportunity to reduce cost on drug discovery and development. In pharmaceutical industry, technology transfer refers to the processes that are needed for successful progress from drug discovery to product development to clinical trials to full scale commercialization as shown in table below or it is the process by which a developer of technology makes its technology available to commercial partner that will exploit the technology. If a pharmaceutical company sells or buys a technology (out-licensing and in-licensing, respectively) at certain stage of drug development, it is likely to help pharma companies. Pharmaceutical companies are constantly looking for integrating technologies to screen and identify potential molecules. With biotechnology industry making rapid strides, pharmaceutical companies

constantly seek to leverage advantage of biotechnology industry in drug discovery. Many small biotechnology firms do not have enough financial capability to develop the discovered technology and proceed with commercialization. With focus of pharmaceuticals on biotechnology as well, major pharmaceutical companies can easily absorb technology from these small biotechnology firms and develop the molecule.

Successful story

According to Mazurkeiwich (2017), barriers in technology transfer can be divided into (1) technical barriers, (2) organizational economic barriers, and (3) system barriers.

1) Technical Barriers
   As Stethee is a medical device, one of the main technical barriers is getting approval from the regulatory bodies. In this case, the developer worked closely with researchers from Texas A&M University, MIT and the Mayo Clinic which have vast experience in technology development. FDA consultants were appointed to help in preparation for FDA submission.

2) Organizational economic barriers

   Organizational barriers may occur at various levels. The barrier may occur if the technology developed, did not fulfil the requirement of the end user. However, in this case, Stethee was developed by clinicians for clinicians, thus it fulfils the requirement of the user. Furthermore, it is simple and easy to use, which enhanced its acceptance.
   Doctors and other health care providers have used stethoscope since more than 200 years ago. It is an essential tool. With digital stethoscope like stethee which is enhanced further with the use of apps, the technology is easily accepted and welcomed. The potential for Stethee to be used in remote and rural areas of Malaysia is enormous and endless, bringing high quality healthcare to the urban and rural areas instantly.

   An evaluation was conducted at the Royal Brompton Hospital, London and found that it took a doctor, on average, four minutes and 26 seconds to capture six data points. It takes the Stethee 20 seconds to capture 16 data points. So, it saves four minutes of a doctor's time. A group of medical practitioners and clinical researchers at MOH's Clinical Research Centre (CRC), Perak is currently involved in the clinical evaluation of the Stethee Pro stethoscope.

3) System barriers.

   Malaysia was chosen as a place to manufacture Stethee for global market. This is materialized since Malaysia has the infrastructure to support manufacturing of Electrical and electronics (E& E) device. Malaysia is also moving towards Industry 4.0, and has built up capacity for that. For example, Collaborative Research in Science, Technology and Engineering (CREST) was set up to act as a catalyst that accelerates Malaysia's economic growth, by creating a vibrant R&D ecosystem for E&E industry, and bring together Industry-Academia for collaborative R&D. As mentioned by Dr Nayyar in an interview by the EDGE "I know Crest is a catalyst, but this was supercatalysm. The important thing was that Jaffri had the vision and the manufacturer also had the vision. And when they saw the prototype, they agreed that it had a lot of disruptive potential and could do a lot of good — in the sense that it is AI, it is something that can go global and help a lot of people."

In general below are some of the challenges and barriers faced by the stakeholders in order to develop a successful innovation in health industry:

i. Research tool patents and freedom to operate particularly in the public sector - Patents sometimes make it difficult for public researchers to carry out their research or to make the products of that research available. It is intensified by the tendency of some publicly funded research laboratories to avoid use of a patented technology without permission even in economies where no relevant patent is in force.

ii. Lack of government focus low market share – local producers face significant challenges in meeting International Quality Standards and capturing a critical market share. Greater market share would increase profitability.
iii. Web access and scientific publication - restricted access to scientific journals directed to massive complications for developing economy's scientists.
iv. Cost of prequalification - there is profit in meeting International Standards since it opens up the opportunity for trading across the entire world.
v. Security issues and restrictions on exports of particular technology - international controls designed for security and to prevent the proliferation of important technologies also restrict the flow of technologies.
vi. Inadequate funding in important areas and possible treaties - there are areas of research of importance to the developing world that are being funded inadequately.
vii. Labor issues - the pharmaceutical sector demands relatively skilled labor. High labor turnover and absenteeism owing to unattractive conditions of service is negative contributor.

There are many strategies that have be developed and implemented in order to overcome those challenges and barriers. Among of the strategies are as follows;

i. Establishment of Co-operative research agreements. Global support for public sector research was encouraged through cooperative research agreements designed to meet specific goals as the above technologies described earlier. It would seem more feasible to focus efforts on technologies of significant social benefit to the developing economies. Continuous support received from various sectors help to alleviate the barriers and facilitates technology transfer.
ii. Political stability and good transparent governance adopted is also crucial. A economy's relative political and economic stability will influence the rate of inward technology transfer and can be seen as a pre-condition for any technology transfer. Even when research-based pharmaceutical company technology transfers are benevolent in nature, they need to be sustainable in order to achieve their goals. Political leadership is critical to address global and local health challenges and, more importantly, healthcare system capacity strengthening.
iii. In addition, appropriate policies have also helped to propel the growth of health industry particularly pharmaceutical industry. Initiatives such as Bionexus status and promotion of medical tourism, grants, tax incentives for research and development activities and financing schemes are all design to develop and nurture the pharmaceutical industry in Malaysia.

For example, the Malaysian generic pharmaceutical industry has made great progress. Besides providing high-quality and affordable pharmaceuticals to the population, it has contributed significantly to the economy in terms of export revenue as well as holding down the escalating health-care cost with regard to prescription medications. The growth in the Malaysian generic pharmaceutical industry is contributed mainly by the increasing health-care spending and the need to contain increase in health-care costs. It has been reported that health-care spending of Malaysians is growing at about 13% a year. Changing demographics also contributed to the growth in the pharmaceutical market. A growing population together with an increasing ageing population has spurred the demand for pharmaceuticals.
Moreover, the pharmaceutical industry has been identified as a strategic industry by the Malaysian government to be promoted. Also, being a member of the Pharmaceutical Inspection Co-operation Scheme has helped to improve the standard and quality of the generic industry. This has, in turn, facilitated the export of Malaysian pharmaceutical products overseas to over 30 economies, including those in ASEAN, Africa, Middle East and Central America as well as to gain access to member economies like the European Union, Australia and Canada.

Recommendations

In order to success in technological innovation ventures, the most important factor is the innovation itself. The innovation must meet end user expectation. It should be something practical and useful for many people. The research should be planned early to show that the technology is safe and effective.

Commercializing publicly funded technologies - The basic pattern envisioned is to give institutions receiving public research funds the right to obtain and exploit patents on inventions developed in the course of research.

Appropriate Capital Markets - For many governments seeking to expand technological capacity, attracting direct investment is very important, but there is also a question of making the most of the spill over benefits of investment. This can reveal a need for adequate capital markets. Governments can also promote inward investment through tax breaks and other forms of incentives designed to encourage technology transfer, in compliance with international trade rules.

Alignment with Economic Development Priorities - The finite or limited resources available to governments imply that measures taken to promote technology transfer need to both be realistic and to fit with overall policy goals. A technology transfer policy dedicated to the creation of completely new types of economic activity and one which is as complex and as highly regulated as the pharmaceutical sector can present a much bigger challenge than building on a sector that already exist.

Possible treaty on scientific access - There has also been a proposal for an international treaty on access to knowledge and technology negotiated on the basis of the type of reciprocity found in normal international trade negotiations. The concept is mean to be non- zero sums in the sense that, like free trade in goods, free trade in scientific ideas benefits all and such arrangements could be made bilaterally as well as multilaterally.

Lastly both scientific community and industry need to identify R&D niche areas so that the county may have the competitive edge in future development.

2.6 A new synthetic nanoparticle applied to gene therapy of Parkinson's disease

América Padilla Viveros
aviveros@cinvestav.mx

Head of Knowledge Commercialization Agency

Center for Research and Advanced Studies

Mexico

Summary

Researchers of the Center of Research and Advanced Studies (CINVESTAV-Mexico) led by PhD Daniel Martinez-Fong have now developed a synthetic nanoparticle that can deliver genes directly and specifically to dopaminergic neurons of the substantia nigra in the brain. The nanoparticle is a neurotensin polyplex consisting of compacted plasmid DNA encoding the gene for brain-derived neurotrophic factor (BDNF) surrounded by three peptides. The peptides target dopaminergic neurons and deliver the plasmid payload to the cell nucleus after internalization of the receptor. The nanoparticle, dubbed Cinvestav-PX-001, is being applied to the gene therapy of Parkinson's disease (PD). Cinvestav-PX-001 has shown great specificity in neuronal delivery, is cost-effective to synthesize and has an optimal biosafety profile, all of which make it an excellent alternative to viral vectors for PD gene therapy. A business intelligence analysis was performed with the support of National Fund of Innovation (Finnova) and the pre-commercial maturation of the product was extended.
Cinvestav´s Technology Transfer Office (TTOs) started the negotiations with potential partners to perform the phase 1 and phase 2 trials in humans and Cinvestav is planning to spin out a locally funded company around the nanoparticle technology and is in a position to offer a non-exclusive license to conduct the trials.

Economic context

Cinvestav-PX-001 is going to the market of supplies for gene therapy. The growth that is projected for the market is 2.8 billion dollars in 2024 and the leading companies are located in United States, Japan, United Kingdom, France, Germany, Italy and Spain. There are more than 500 candidate molecules for gene therapy at different stages of development. Approximately 1,700 clinical trials are conducted in several regions globally. An increase in the number of candidates is caused for the rapid progress of phases of clinical development, in favor of the demand for new and more secure molecules. The market has a wide variety of players and stakeholders. Several industrial representatives as well as academic institutions are important in the production of vectors under good manufacturing practices (GMPs). In the past, key players established multiple alliances and collaborations in order to optimize and scale the process of vector production and expand their capabilities. Regarding the trends and evolution of the market technological advances to mitigate the challenges posed by conventional vector production methods will act as a key factor for growth. Derived from the competitive intelligence study, we conducted an analysis of prior art based on scientific documents and patents related to PD treatments. As a result, we identify the 20 leading companies in this field from a total of 4105 patent documents. The list is headed by three global companies that together represent a third part of the total of identified patents. The analysis of leading economies in patents related to gene therapy treatments for PD (based on the number of documents) have showed that the leading economy is United States of America (more than 900 documents), followed by Canada, Mexico, Brazil, China, Australia, Japan and some European economies, which have a similar place in the development of technologies of this type. Currently there are few vectors in pre-commercial development for the approach of PD by gene therapy; all of them are viral vectors. From the analysis of the competitive landscape and market assessment, we conclude that 3 companies (one in USA and 2 in Europe) has the potential to license Cinvestav-PX-001 and all have been contacted.

Innovation system

Since 2013 the Mexican government is continuing to reinforce the instruments and strategies set forth by the National Development Plan (2013-2018) for ensuring sustainable socio-economic growth. The Special Program for Science, Technology and Innovation (2014-2018) was designed to transform Mexico into a knowledge-based economy by: 1) increasing investment in science, technology and innovation (STI); 2) forming highly qualified human resources in science and technology (HRST); 3) strengthening regional development; 4) promoting science-industry linkages; and 5) developing the infrastructure for STI. The federal government budget for STI is expected to increase by 25.6% during 2014-2018, with gross domestic expenditure on research and development (GERD) set to rise to 1% of gross domestic product (GDP) by 2018 (OECD, 2016). GERD indicator as a percentage of GDP maintained a decreasing behavior, representing 0.53 and 0.50 percent in 2015 and 2016, respectively. The researcher's number for every 1,000 people of the economic active population reached in 2015 and 2016 the value of 62.4 and 64.4, respectively. A published scientific article per million inhabitant's indicator has maintained an increasing trend, resulting 104.7 in 2016 (CONACYT, 2016).
As in other Latin American economies, Mexico´s ratio of business enterprise expenditure on research and development (BERD) to GDP is well below the OCED median, the Council for Science and Technology (CONACYT), which manages around 40% of the public STI budget, seeks to encourage business research and development, and innovation, essentially through competitive grants. Its innovation incentive program (PEI) has proved to be effective in stimulating business innovation, particularly in small and medium enterprises (SMEs).
In the Top 500 of the institutions dedicated to Research and Experimental Development (R&D), the Web Ranking of World Universities ranked only two Mexican institutions: the Center for Research and Advanced Studies of the IPN (Cinvestav) and the National Institute of Public Health, with the place 109 and 455, respectively (CSIC, 2016).

Considering the legal framework for most universities and research centers in Mexico, the licensing of intellectual property rights is the most applied mechanism for technology transfer. In this particular case, the non-exclusive license with territorial delimitation of the family of patents claiming Cinvestav-PX-001 is on negotiations.

One of the most innovative instruments of policy implemented in recent years in Mexico is the Technology Transfer Offices Program supported by CONACYT and the Ministry of Economy through Finnova fund.

In 2017 Finnova approved the certification of 59 TTOs as a result of its technology transfer outcomes and indicators.

Successful story

As demonstrated by the analysis of the competitive landscape, a number of promising gene therapies are currently being developed worldwide and are in the stage of commercial maturation (clinical phase), with the balanced participation of the business, academic and government sectors. Given this perspective, is expected that the efforts will result in several cases of commercial success in the future. In this global outlook, it is strategic for Cinvestav, one of the leading centers of research in Mexico, to develop affordable mechanisms with the purpose of transferring the knowledge resulting from the scientific research in the field of gene therapy to its counterpart in the productive sector, to position this alternative that improves the quality of life of patients with PD disease. To achieve this, was necessary to articulate the resources and actors in a business case considering market entry strategy, analysis of the competitive environment, the financial projections, the feasibility and financial risk analysis, the setting of scenarios to define the value of the technology, the design of the strategy to identify potential licensees and the establishment of the negotiation bases and terms and conditions of licensing.

The Business Case of Cinvestav-PX-001 was designed by the TTO of Cinvestav, which is one of the 59 certified TTOs (2017-2019). In 2014 the TTO of Cinvestav received a grant from Finnova for developing the pre-commercial maturation of the non-viral vector for use in gene therapy of PD, in partnership with local actors of the ecosystem such as the National Network of Technology Transfer Offices (OTT Network) and international partners, such as the Newton Fund and the TTO of the University of Oxford. Through the support provided by Finnova and Cinvestav (200,000 USD), the technical area in the laboratory was conditioned to establish the optimal conditions for the production and use of nanoparticles. In the implementation of the proof of concept, progress was made towards the pre-commercial stage through tests documented in the handbook of detailed and standardized protocols for the synthesis, characterization and application of the technology called "Protocols of the NTS-poliplex in Nanomedicine" (Milestone 1). Preclinical studies were completed on the biosafety of nanoparticles and have suggested no adverse side effects, as they do not cause local or systemic inflammation. On the other hand, all the activities for the business development were integrated in the Business Case of the project (Milestone 2) including competitive intelligence, market assessment, technology valorization and negotiation scenarios.

Technology valuation and negotiation scenarios showed that the project would not be attractive for an investor or potential licensor because the rate of return required in this stage technology readiness level (TRL) 3 is very high and the investment required is also very high. Based on the above, we have recommended that in order to reduce the risk of the project and make the model more attractive for a potential licensor, the technology will take to a more advanced stage of development, ideally to phase 3 of clinical trials, considering some of the following mechanisms: a) Investment and tests by the owner of the technology b) Investor carries out the clinical tests in exchange for the option of obtaining a license or assignment of rights c) That the model offered to the investor be exclusive and worldwide license to be profitable. If in the future as part of the development of clinical trials there are improvements to the technology that are patentable, it is essential to obtain the intellectual property in as many economies as possible, since the real possibility of attacking markets exclusively will imply a greater return and will make the project more attractive.

On the other hand, although the plan considered conducting a Preliminary Examination of International Search (Milestone 3), due to the time required for the formalization of the allocation of resources (critical barrier), the timing was exceeded and patent application via the Patent Cooperation Treaty (PCT) was already in the entry to economy phases, so the milestone was modified to make the payment of the annuity for patent rights 2015 and preparation of the response to official action before the European Patent Office (adjusted Milestone 3) An adjustment was made to pay the preparation and presentation of patent application economy phase at United States of America and the payment of preparation and presentation of patent application regional phase in Europe (Milestone 4). Derived from the revision of the claims (Milestone 5), a comparative analysis of the relevant documents found in the competitive intelligence and market study was carried out. Whenever the documents referring to the main technologies related to treatments of PD by gene therapy were found by using neurotensin polyplexes with the BDNF, and that the main competitor for the technology was determined, a comparative analysis was carried out to identify the similarity of the patent families of this competitor and Cinvestav, and an analysis of freedom to operate (FTO) was carried out to determine their real opportunity. With the support of the Newton Fund through the program Leaders in Innovation Fellowship (United Kingdom) conducted by the TTO of the University of Oxford, and Mexican Network of TTOs a deep analysis against the principal competitor was performed. In particular on the regard that their patents could be considered prior art for our family patents. After reviewing the competitor's patent portfolio, three families of patents directly related to Cinvestav-PX-001 were identified and the competitive position of the patents owned by Cinvestav was determined.

In Mexico there are no specific regulations for gene therapy, the recommendations and specific requirements will be determined mostly by the Committee of New Molecules and the Subcommittee for the Evaluation of Biotechnological Products. A regulatory analysis for the commercialization of the product in the European Union (EU) and USA was done (Milestone 6). The results indicate that in the EU and USA, there are specific regulations and regulatory guidelines concerning gene therapy and the use of nanoparticles. However, the path for sanitary and commercial approval is still unclear, so the opinion of the committees of each regulatory agency will also be fundamental in the process of approval of the non-viral vector for use in gene therapy of PD. By not containing living organisms or their derivatives, or viruses as a product, the vector has the regulatory advantage of not requiring compliance with certain standards, mainly EU and USA, applicable to the use of viruses and microorganisms. Due to the lack of regulatory information on the effects of products related to gene therapy, the regulatory process may require more strict and extensive tests than those that require known therapies, so it is expected that the investment required to perform them is much greater than in a traditional medicine product, even biotechnological. The main guidelines and case studies in this regard can be found in a compilation of Regulatory Analysis. Executive proposals and non-confidential information were sent to chosen companies in USA (3), UK (2) and Mexico (1) (Milestone 7) that were contacted trough BIO International in San Diego, Philadelphia and San Francisco USA, taking advantage of business platforms as "one-one partnership", global innovation hubs and "Biopharma dealmakers" journal. A non-disclosure agreement (NDA) was formalized with a Mexican global bio-pharmaceutical company (Milestone 8) with facilities for producing nanoparticles under GMPs and investing in central nervous diseases innovations including PD. Cinvestav is currently waiting for it pronouncement for the terms and condition for licensing. Human resources (3 PhDs) were trained as a group of innovators with experience in the development of non-viral vectors for use in therapy and tech transfer (Milestone 9) currently are working in TTO of universities in Mexico City.

Recommendations

According to the experience obtained in the field of gene therapy in neurodegenerative diseases of the central nervous system, we consider three aspects in the establishment of the recommendations:

a. To overcome the challenge imposed by pharmaceutical development projects that requires an intensive investment of financial resources and large time, we take advantage of federal funds, which allows advancement in TRL without demand to quick return of the investment.
b. One of the biggest challenges for the academic sector is the efficient management of intellectual property rights, and this aspect is strategic in the commercial positioning of inventions. In Mexico, academic institutions do not have a budget that allows covering the requirements and payment of rights, and budget is very restricted. In this case, it was essential to have a budget for specific issues as FTO analysis and annuities in Mexico and in the world; this barrier was overcome with the support of the Finnova Fund that considered this issue as part of the allocations and with the assistance of the Newton Fund.
c. The biggest of the challenges was cover the regulatory lack of information in Mexico, in our case in addition to the analysis made in the office, USA and Europe, information was collected from international regulatory agencies in European economies such as Germany, Spain and the United Kingdom, with relevant standards and practices that promote the design of new strategies to shorten market entry. Will be very useful to know about Asia and Pacific best practices at APEC event.

Finally, the most important aspect of the project is the social impacts as a result of the transfer of knowledge to the productive sector that will allow improve the quality of life of patients with PD, which is the legitimate mission of Cinvestav.

2.7 The case of Food Processing Pilot Plant

Patricia Ocampo
pocampo@ciatej.mx

Director of Southeast Unit Department of Science and Technology

Center For Research and Assistance in Technology and Design of The State of Jalisco

Mexico

Summary

An effective combination of infrastructure from a public research institution (CIATEJ) and finance from state and federal funds have supported the collaboration between researchers and producers in the agro food sector in Yucatan and had made it possible for the successful development of new food and beverage products using local resources. The collaboration has enable the tangible transfer of intellectual property, expertise and skills to producers helping the sector to add value to their businesses and to transit from primary producers to processors and become more competitive.

At the infrastructure level the central element is the CIATEJ Food Technology Unit with research laboratories and a Food Processing Pilot Plant (FPPP) that helps to develop new products, and also to measure the quality, physical and chemical characteristics of the end products and its raw materials. The use of the FPPP has allowed the design and development of processes and equipment and to scale up and optimize processes to the industrial level with minimal risk to the enterprises.

Newly develop funds such as Innovation Stimulus Program (PEI) and the Fund for Innovation Entrepreneurship of Yucatan (FONDEY) have been fundamental in the process enabling the work between the academia and the non-academic community.

Economic context

Mexico is the 11th largest economy in the world and since 1994 (when NAFTA entered into force) has become increasingly oriented toward manufacturing and its agricultural and food industry are increasingly market-oriented. In 2016 Mexico was the United States' third largest agricultural trading partner, accounting for nearly 12 percent of total American agricultural exports and 53 percent of Mexico's total agricultural imports. Agriculture employs 13,4% of the labor force but only contributes to 3,9% of its GDP while industry contributes 24,1%.

The food and beverage industry is the most important in the manufacturing sector, in 2013 accounted for the 21,5% of the Manufacturing GDP and 3,7% of the economy's total. Between 2016 and 2017 food production presented growth rates higher than that of the economy, with bakery and tortilla products and slaughtering, packaging and processing of meats de most important activities. However, Mexico currently imports 43% of its total basic foods, among the imports are the ready to eat products, which for example in 2014 reached a total of 585 million Canadian dollars approximately 31% of the total Canadian agri-food exports to Mexico. According to the Canadian Trade Commissioner Service, exports of value-added food products to Mexico have been increasing over the past 5 years.

Yucatan's economy has been growing steadily since 2014 with an average 4%. Yucatan is the ninth more important state in the mexican food industry and accounts for 4% of its GDP. There are 80,000 hectares of fertile land and abundant subterraneous water. The food industry in the State is becoming very important due to new investment in the manufacturing industry and mayor exports to economies like Asia, Africa and Europa. According to the Yucatan Economy Secretary in 2017 Yucatan had 20% more Direct Foreign Investment than in the previous year, 7.6% of this investment went to the food and beverage industry.

Innovation system

The innovation system for the development of new food and beverage products using local resources consist of a Food Technology laboratory whose research is oriented towards the development of new innovative products and processes in food and beverages, obtaining metabolites of interest as ingredients, natural additives, and food supplements, the development and conservation of regional foods, as well as fermented and / or fortified foods.

Once the new processes or products are identified and developed in the laboratory and final users are identified the scaling and optimization of industrial processes is done through a FPPP. The most important characteristic of the FPPP is its flexibility that allows for several lines of products to be assemble.

A fundamental aspect in the innovation process is the specialized human resources in the institution and the presence of a technology transfer office which actively engages with local stakeholders in the agro food sector to identify their requirements and needs. The creation of specialized federal and state funds where industry in collaboration with local research institutions can compete for research money to solve their problems or meet their needs through innovation completes this innovation system.

Successful story

Using the research laboratories and the FPPP located in Estate of Yucatan CIATEJ has been able to successfully transfer several new products and process to the agro-food industry in the region. During the last two years the food research laboratory and its FPPP has been working with local businesses in the development of 1) new product lines (development of new functional drink using local sub products and development and scaling up of two new bakery healthy products) and 2) development of novel products (a pilot process for the elaboration of regional foods in ready to eat pouches and development of healthy fish product).

Case 1: New product lines:

Development of new functional drink using local sub products

A local relatively new SME that produces drinks approached CIATEJ for the use of one of the patents developed in the institution. The researchers developed a proposal to meet the requirements of the SME with the objective of establishing the process for the elaboration of beverages supplemented with hesperidin and natural regional flavor, insuring its quality and an extensive shelf life. The SME submitted an integral proposal to the PEI, a federal fund that finances up to 65% of funds for innovation research by enterprises. The main requirement of the fund is that the enterprise works with a research institution and that the final product is transferred from the research institution to the enterprise. During the development of the project, the researchers and the SME work hand in hand to be able to achieve all the deliverables and finish the project on time. This work enabled a proper collaboration between the institution and the SME and a better understanding of the business needs by the researchers. The collaboration and understanding made possible to overcome problems encounter during the development of the project. The end result was a new line of beverages for the SME with functional characteristics and using local sub-product. The new line is in the local market and the SME is presently working with CIATEJ developing new products.

Development and scaling up of two new bakery healthy products with antioxidants.

Giving the current demand for healthier bakery products a well-established large local enterprise approached CIATEJ to help with the development of a new line of bakery healthy products with antioxidants. The proposal was successfully submitted to PEI by the enterprise and a new line of healthy products was developed and scale-up. The project was selected as a successful case by the PEI program and the enterprise launch the new line of products, which are currently in the local market.

Case 2: Development of novel products

Pilot process for the elaboration of regional foods in ready to eat pouches

Following the success of PEI, the Yucatan state, together with CONACYT developed a State Fund for the support of innovation and entrepreneurship in Yucatan: FONDEY, launched in 2016. In 2015 a local association of producers from the state visited CIATEJ as they were interested in developing new regional food products to add value to their businesses. The association's main product was pork meat, which was sold frozen to the local market. When the FONDEY was launch, CIATEJ informed the Association and together they developed a circa $90,000 US dollar proposal that was successfully submitted to the Fund. The objective of the project was to establish a pilot process for the elaboration of regional foods in flexible sterile pouches. The specific objectives were to study the physiochemical and microbiological quality of several regional recipes under different variables such as cooking time, size, thermal treatment and packing and to choose some of the recipes to carry out tasting panels and specific treatments to increase shelf life.

Giving the specifics of the project during its development, the researchers and the association worked very closely to be able to choose the best local recipes and to achieve all the deliverables and finish the project on time. Additionally, as one of the deliverables was to validate the pilot process in the Association's premises, the researchers needed them to know very well the equipment and the site. The excellent collaboration developed during the 16 months' work and the understanding of the pilot process and the new facilities made possible to overcome several logistical and equipment problems encounter during the development of the project. The process has been validated and adjusted in the Association facilities and the new product is ready to launch. It is important to note, that the Association has invested circa 2 million dollars in its new facilities and the marketing development of the new product.

Development of healthy fish product

A local aquaculture SME approached CIATEJ with the requirement to develop a new added value product for its fish. A proposal was summited for the development of new formulations of healthy fish food product with natural additives, pack in high vacuum and thermal treatment. The project was successfully submitted to PEI and the end result is a new product that is been offered in the local supermarket chain. As in the other cases detailed above, there has been a intensive collaboration between the researchers and the SME which has enable an effective and tangible knowledge transfer of intellectual property, expertise and skills between researchers and local businesses and entrepreneurs.

Recommendations

Since its beginning CIATEJ has been transferring knowledge to the industry sectors it serves. Through the Food Technology Unit CIATEJ is generating the knowledge necessary for the development of the food and beverage productive sector to help the sector to become more competitive. The central element for effective knowledge development and its transfer is the

CIATEJ Food Technology Unit with research laboratories combined with the FPPP. The use of the FPPP has allowed the design and development of processes and equipment and to scale up and optimize processes to the industrial level with minimal risk to local producers and enterprises.

Another fundamental aspect in the innovation process is the specialized human resources nurtured in the institution and the presence of a technology transfer office which actively engages with local stakeholders to identify their requirements and needs. The creation of specialized federal and state funds where industry in collaboration with local research institutions can compete for research money to solve their problems or meet their needs through innovation, have been fundamental in the process enabling the work between the academia and the non-academic community and completes the innovation system.

Our opinion is that an effective combination of infrastructure from public research institutions and finance from innovation state and federal funds make possible the successful knowledge transfer and supports collaboration between researchers and producers. Collaboration enables tangible transfer of intellectual property, expertise and skills to producers helping the sector to add value to their businesses and to transit from primary producers to processors and become more competitive.

2.8 Feed enzyme from local microorganism

Thininut Srichan
Thininut.sri@biotec.or.th

Director of Biotechnology Business Development Division

National Center for Genetic Engineering and Biotechnology

Thailand

Summary

Aspergillus spp. fungi is found to produce several enzymes, especially pentosanase, which can be used to digest non-starch polysaccharides in animal feed raw materials so that animals can absorb and utilize more nutrients. In return, meat yield and animal health are improved. In addition, the harmless fungi can perform effectively at temperature and pH, which are the environmental conditions inside animal stomach and small intestine. Pentosanase produced from Aspergillus spp. was tested at an actual pig farm and outperformed the imported enzyme when used as feed additive.
The technology to produce pentosanase from Aspergillus spp. as feed enzyme developed by National Center for Genetic Engineering and Biotechnology (BIOTEC) was licensed to Asia Star Animal Health Co., Ltd. (ASAH) The product is currently available under the trade name “A-Zyme”. Later on, the company obtained the license to the technology to increase activity of non-starch polysaccharide degrading enzymes developed by BIOTEC, and released a more potent product named “Pentozyme”. The products are well accepted by farmers shortly after the product launch because of its performance. Nowadays ASAH become high performance enzyme manufacturer and still continues work closely with BIOTEC in research and development in feed additives and enzyme production.

Economic context

Thailand was classified an upper-middle-income economy by the World Bank in 2016. Thai economy is expected to grow at an average annual rate of 3.6%. Thailand 4.0 is a new economic model, aimed at pulling Thailand out of the middle-income trap and developing it as a high-income economy. It focuses on a value-based economy, as the economy needs to deal effectively with disparities and the imbalance between the environment and society.

Innovation system

Thailand was classified an upper-middle-income economy by the World Bank in 2016. Thai economy is expected to grow at an average annual rate of 3.6%. Thailand 4.0 is a new economic model, aimed at pulling Thailand out of the middle-income trap and developing it as a high-income economy. It focuses on a value-based economy, as the economy needs to deal effectively with disparities and the imbalance between the environment and society.

In Thailand, The public research structures is well developed. Number of public bodies have been established, reporting to different ministries and agencies, involved in basic and high technology research. There are around 150 tertiary educational institutes. 9 research universities account for the bulk of publication in international journals. Both public research institutes and universities try to link with industry. Number of technology transfer from public institutes and universities is increasing.

The most innovative manufacturing firms are in the chemical, electronics, food, rubber, machinery, and oil and gas industries. Larger firms tend to engage more in innovation but level of involvement varies depending on sector and financial resources. SME sector is dynamic however there is not high technology-intensive or innovative. New technology-based firms have emerged and keep growing.

STI and NRCT account research policy while there are several government bodies in charge of financing R&D such as NRCT, TRF, NSTDA, ARDA, HSRF and OHEC. More than 20 schemes promote innovation in the business sector, managed by several agencies such as NIA, TCELS, NSTDA, BOI, Thailand Science Park and regional science park. Major R&D investment currently coming from government sources, however, private R&D investment is improving.

The main technology transfer mechanisms used in Thailand including; Consultation and technical services, training, technology licensing, joint venture, collaborative research, contract research, startup/spin off.

Successful story

Animal Feed and Feed Supplement Feed play important roles in livestock production. For example, the presence of non-starch polysaccharides and natural anti-nutritional factors in feed can constrain both commercial and intensive animal farming because the animals cannot properly digest the feed, leading to lower animal productivity. The use of microbial enzymes as a feed supplement to enhance nutrient availability is becoming more common and it has the potential to increase animal productivity.

Back to last decade, Thailand’s feed market was huge, but relies much on import, especially feed enzyme. There was no industrial enzyme production facility in Thailand. Asia Star Animal Health Co. Ltd. (ASAH) was a veterinary medicine company that was found with the philosophy of sustainable development in agriculture industry. The company realized the limitation of imported feed --- price and nutrition. The company attempted to overcome this restrictions. The solution was to increase feed digestibility. Feed available in market at that time was about 80% digestible. That’s mean every 100 Baht we spend on feed, we lost 20 Baht. Million tons of feed are used in Thailand annually, so a lot of money was wasted.

Since 2004, National Center of Genetic Engineering and Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA) had developed the production technology which uses the pentosanase-producing microorganism carefully screened from the BIOTEC Culture Collection and the process to achieve a final product in powder form. Pentosanase produced by BIOTEC has shown great result in lab and demonstration farm. IP filing and publication in international journal were done in during 2007-2008.

ASAH was established as a trading firm of feed products and feed raw materials. In 2004, the company set its vision to build up business sustainability, so they decided to become a high quality feed manufacturer by using biotechnology processes. It was the time ASAH met with the research team and showed strong interest in this technology.

Although the technology was sound promising by positive result in lab, IP protection and publication, however, the most challenging task for both side was the proof if the technology is scalable and producible with acceptable cost. At that time, neither BIOTEC nor ASAH has enzyme production facilities. More partners came to the picture, BIOTEC in collaboration with ASAH decided to seek for collaboration with university for pilot production and field trial in pig farm. The study showed successful result.

In 2009, ASAH signed a license agreement to produce pentosanase as a feed enzyme using a local microorganism screened from the BIOTEC Culture Collection. The company has been

releasing feed enzyme products under the trade name A-Zyme. ASAH had successfully developed and commercialized first enzyme product that are used as effective tools for managing feed costs and feed ingredient quality variations -- safe for animals, humans and environment. In 2011, ASAH acquired an additional license from BIOTEC for technology to increase the activity of non-starch polysaccharide degrading enzymes, which the company turned into a new product called PentoZyme. The products were well accepted in market both in Thailand and neighboring economies. The economic impact of these technologies was estimated to be 131.69 million Baht in 2012. Estimates were based on company revenue on product sales, the import substitution value of the enzymes, and the yield improvements passed on to farmers using ASAH feed enzymes.
In 2013, BIOTEC and ASAH signed a licensing agreement to facilitate the transfer of feed enzyme technology developed by Bioresources technology unit to the company for commercial production. The technology, derived from a collaborative research between both parties, includes the new fungal strain, Aspergillus sp., which was screened from BIOTEC Culture Collection and the solid state fermentation technique for enzyme production. This new fungal strain is capable of producing high level of multi-enzyme complex, mainly carbohydrates, with high stability under low pH condition.

This was their third licensing agreement. The first two agreements have brought an assortment of feed products to the market. New product using this newly acquired technology was launched in 2014. In addition, the success of products had led an expansion of company's enzyme production factory, which is partially financed through NSTDA soft-loan program for companies investing in technology development. The new factory was opened in 2014 under Asia Star Trade Co.,Ltd.,(AST) a new set up company, was set up to manufacture enzymes for domestic and export market.

Since these feed products are based on local microorganism, they perform well under tropical environment, local breeds and conditions. The production is located locally, so the products are not subject to long-haul shipment, unlike imported products. The users can be sure that they will always receive fresh product. The enzyme quality does not effected by logistic time plus logistic cost saving.

Today, ASAH and AST manufacture feed supplement based in the research conducted by BIOTEC. Their products are well accepted in market. The company has increased production capacity along with creating new products based on fermentation technology with international standard facilities. The company invested in high standard factory and machinery as well as qualified staffs to deliver high quality products to market.

Moreover, the company continue improving their products by employing new technologies acquired from research institutes such as BIOTEC. There are number of collaboration projects between ASAH, AST and BIOTEC in enzyme/fermentation process in feed and other industries arise in past 10 years. The collaboration between industry and research institutes could increase success rate of the research collaboration and commercialization.

The main task of the National Center of Genetic Engineering and Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA), Thailand, is to conduct research to develop technology and innovation which can solve the problems and meet the need of the economy in both short and long term. BIOTEC is committed to academic excellence in agriculture and food, biological resources, public health and medicine, and energy and environment, and to translate the results to benefit economic and social development.

Recommendations

- Direct cooperation between public research institutes with local industry. Work closely with industry since the beginning will increase success rate of commercialization and technology transfer. Industrial partner will help research team identify real pain point that need to be solved and what market really want. Joint/contract/sponsored research are important tools as well as technology licensing. Collaborations help speed up time to market.

- Proof of technology. Most of companies do not want to take too high risk. Therefore, they want last stage of development to make sure that technology works well in pilot/industrial scale with desirable quality and specification. With limited resources, government support is always desirable. E.g. Funding support for development, facilities for pilot test, testing facilities. It could accelerate technology transfer process.

- Roles of inventors. Inventors/researchers play important roles in technology transfer process especially in developing economies since companies may be not yet ready to adopt technology. Some of them come from trading company who do not have adequate experience in adopting technology or production. Inventor/researcher's effort and time are highly needed.

- Strong network will benefit technology transfer. Not only matching technology seekers with technology providers but also bringing in other needed jigsaw to complete the picture.

- Law and Institution policy related to IP management and technology transfer. Law and Clear policy will allow stakeholders work effectively in their part and spend less time with negotiation. E.g. ownership of invention and benefit sharing between grantee and granting agency.

- Need of skilled professionals in Technology Transfer. Technology transfer experts are not easy to find all over the world. Person, who are good at science with business understanding, can be trusted and appreciated by researchers, as well as being able to deal with business sector. Capacity building is needed for technology transfer professionals.

2.9 Successful technology transfer case report from the Philippines

Merlita M. Opena
mmopena@pchrd.dost.gov.ph

Philippine Council for Health Research and Development
Department of Science and Technology

The Philippines

Summary

The technologies on medicinal products from herbal plants – lagundi (Vitex negundo L.) for cough remedy and sambong (Blumea balsamifera L.) for kidney stones are described in three periods, and contrasted to other technology transfer events. First, in 1988, a company adopted them as part of their corporate social responsibility to the communities where their cement plants were. The motivation here was for the results of researches under the medicinal plants program to benefit the population, given the long-time support to the program that started in the 70s. Then, in 1995, three pharmaceutical companies adopted the technologies, based on a selection guideline; one of these companies successfully marketed the products, starting in 1997, generating royalties to the research team and a share to the government funder, the Philippine Council for Health Research and Development, Department of Science and Technology (DOST-PCHRD), the latter's share was remitted to the government treasury as income. Post 2009 when the Technology Transfer Act (RA 10055) was passed, PCHRD transferred the ownership and technology transfer work to the university that generated the technology.

Contrasted to the knee replacement system, a research undertaken by a private company in 2012 and jointly funded by PCHRD and the company, was immediately used by orthopedic surgeons, and for which the company plans not only to supply the Philippine market but Asia as well. For PCHRD to fund a private company's research, a policy was presented to the PCHRD Governing Council and approved. This instrument guides PCHRD in funding private companies. This particular company is in the biomedical device business, the owner is an orthopedic surgeon who practice in the US, and has a company with a research laboratory in Minnesota.

An example of a technology which was not commercialized in the early 90s was on Hepatitis B diagnostic kit. From a research institute, this was adopted by a company which was partly owned by a researcher which did work on hepatitis B. The company rented a space in a technology business incubator located in DOST. While the beginnings looked good, the technology was not launched – a new technology came out in the market which made the diagnostic kit obsolete.

Income streams came as royalties, one time block fund, and shares through a spinoff company.

Economic context

The economy which has the second youngest population in ASEAN has a population of 105M (2017). The median age is 24 years old, and life expectancy is 73 years old. The Philippines grew by 6.7% in 2017; in terms of growth, it placed third in Asia Pacific region, next to Viet Nam and China. It has a GDP/capita of USD 2,978. Unemployment has gone down but underemployment is still significant.

The mortality and morbidity profile of the economy shows an equal proportion of infectious and lifestyle diseases.

The high cost of drugs and health products is one of the factors which limits access by the population to health care services, hence, the research priority on drugs from herbal plants, diagnostic kits, biomedical devices, functional foods, among others. Since 2011, the PCHRD worked on a two-track Drug Discovery and Development Research Program, given the economy´s rich biodiversity – the herbal track which leads to standardized herbal drugs and a drug track towards synthetic drugs. A complete list of the National Unified Health Research Agenda (NUHRA, 2017-2022) is downloadable at www.pchrd.dost.gov.ph.

The technologies on medicinal products from herbal plants (lagundi and sambong) had a two-pronged mission -- promoting the use of drugs from herbal plants, which were scientifically validated and studied, for community use, by preparing them as household decoctions. The other track was subjecting these herbal plants, prepared as tablets or syrup, to clinical trials like any Western medicines, and registered with the Food and Drug Authority (FDA).

Producing medicinal products from herbal plants brings farmers into the loop, inviting them to go into large scale planting of herbal plants to supply manufacturing requirements. This component contributes to the productive use of agricultural lands, income and employment.

The Philippine pharmaceutical industry, the third largest pharmaceutical market in ASEAN worth 3.6B in 2016, is dominated 70% by foreing companies. Among the local companies, United Laboratories leads in terms of size and sales volume.

One of the big purchasers of drugs is the Department of Health (DOH). The budget of the department has increased over the years (USD 2B in 2017 out of the total government's budget of USD 67B). Affiliated with the DOH, is the Philippine Health Insurance Corporation (PhilHealth), the public social health insurance organization, which advocates the government's universal healthcare coverage goals.

The awareness on patent-free drugs, generics law in place, and research results on herbal plants encourage local companies to undertake research and manufacturing, slowly moving away from a compounding and distribution industry. On the hospital equipment and biomedical devices, the economy is major importer, thus, the thrust on bringing together engineers and health professionals to research and come up with devices which are of good quality with affordable cost.

For a more transparent and efficient regulatory processes, the FDA is streamlining its registration processes and clinical trials management, among the many changes it (FDA) is putting in place.

Innovation system

Before 1995, the contracting instrument was a simple memorandum of agreement, but in 1995 and up to now, a 5-year non-exclusive licensing agreement, was used. This agreement was more detailed, similar to what was used by US technology licensing offices. This was reviewed by an IP lawyer. Note that during the mid-90s, only one practicing patent attorney, and his understudy, was known to u through a visiting Filipino from Silicon Valley. The Intellectual Property Office in the economy was not yet actively involved in technology transfer activities.

PCHRD, as a government funder, whose mandate was to coordinate health research in the economy, was pursuing actual technology transfer, amidst a low level of awareness of technology transfer in the science community. DOST's technology promotion arm, the Technology Application and Promotion Institute (TAPI), reorganized from the Philippine Inventors Commission, was already active in the intellectual property management though, initially catering to non-university-based inventors. The Council (PCHRD) supported IP registration, with the help of TAPI which provided links to patent agents. Access to researchers, the DOH and FDA was facilitated. Promotion in terms of investment forums, exhibits and the like were undertaken to attract potential adopters. For health technologies, our insight was that open promotion was not as effective as purposely identifying and talking with the potential players.

Access to financing through the inventors guaranteed fund which was lodged in a bank was not ideal since banks were still in their traditional mode requiring hard collaterals; they were not into IP assets. Venture capitalists investing in research-based technologies are not present even up to now. Thus, the pharmaceutical companies-adopters in 1995 came up with their own capital. The one company which pursued technology commercialization established a separate entity for drugs from herbal plants, and chose a doctor who used to work with the DOH on its herbal plants to lead this new company.

In the early 2000s, TAPI introduced a program, TechniCom, to provide bridging funds, from lab to pilot scale production. This facility was not fully subscribed as the environment for research and technology commercialization was not that developed, both from the generators – universities and research organizations – and industry which remains risk-averse to investing on research, even within their own companies.

The Technology Transfer Act of 2009 (RA 10055) changed the research to technology commercialization landscape, albeit slow. RA 10055, which built on the US Bayh-Dole Act, gave the entitlement to the technology to the research-generating institutions of government-funded researches. During this time, the Intellectual Property Office (IPOPHL) helped higher education institutions (HEIs) come up with their IP policies. As well, they collaborated with HEIs to set up Innovation and Technology Support Offices (ITSOs) which trained university researchers and staff to be IP professionals, patent agents and undertake their own patent search.

Post 2009, a significant push to set up IP offices, technology transfer/licensing offices, business development offices and the like in HEIs and R&D institutes was undertaken. The focus this time was in capacity building and creating a critical mass of researchers and research managers who understand and are able to run their IP and technology licensing offices. The Asian Institute of Management, in 2015, under the UK-Agham program, started to train researchers to do pitch-ins and to better understand the market and business environment. The DOST introduced in 2017 its Science for Change Program aimed to strengthen centers of excellence in research aligned to the Harmonized National R&D Agenda; bring industry and universities to work on industry-defined problems as well as support industry's research programs in terms of accessing high-end equipment.

Aside from licensing, other forms of transfer were considered by universities like setting up of spinoff companies, although this mode is still difficult as university governance at the present time is not adjusted to the requirement for a speedy technology transfer process borne by the experience of dengue diagnostic kit.

The joint research investment in knee replacement system was a quicker one, given that the implementer is a company which an experience in research, production and marketing of biomedical devices.

Successful story

The overriding motivation why technology transfer was undertaken in the late 1980s, in spite of the fact that PCHRD did not have any experience, and there was just one Department circular (1985) which defined technology ownership and royalty sharing, was for the Filipino people to reap the benefits of publicly-funded research. The attitude was 'just move the technology out to the people" with the money considerations second.

Trust relationships underpin all the negotiations and transactions of the technology transfer process.

The first, and only, company in 1988 which adopted the technologies on drugs from herbal plants was in the cement business. They picked up the technologies for their corporate social responsibility to the communities where their cement factories were. They made use of an existing pilot plant at DOST, hiring former pharmacists-researchers to run the plant. They tried to access the inventors guaranteed fund at a bank but were not successful. Since drug production is not the company's core business, the products were not brought to the market.

Learning from the first experience, PCHRD came up with a selection guideline and made sure that the pitch was made to companies whose core businesses were in pharmaceutical production and had the financial capability to put up the business.

Three companies adopted the technologies in 1995, but only one pursued production and market distribution. One changed its mind because the IP registration was not yet out; the other one was keener on food supplements than drugs. Food supplements were easier to register at FDA since these have no therapeutic claims.

The one company which pursued technology commercialization, in the absence of venture capitalists, put up an investment and established a separate company for drugs from herbal plants, did product development, and chose a doctor who used to work with the DOH on its herbal plants to lead this new company. This doctor-manager found it hard to penetrate the market without doctors' prescribing the products. He championed the products to the Philippine Medical Association, and made the rounds with the doctors and their societies before the products were successfully launched in the market. The success of this transfer can be attributed to the confidence of the owner in the work of Filipino researchers (he's a chemist) and the dogged perseverance of the doctor-manager (he's done business management at the Asian Institute of Management). PCHRD and the researchers made representations with FDA for a separate lane for drugs from herbal plants to facilitate product registration. As well, the Council helped the researchers on the IP registration.

The company tried tapping the international market but was constrained by the limited published articles on the technologies which would have aided the evaluators of that foreign economy.

With the passage of the Technology Transfer Act of 2009, PCHRD, through a memorandum of agreement, transferred ownership of the technology and technology transfer work to the university. The latter need to set up its IP and technology licensing offices, and the learning curve is steep, given their being new to the technology transfer business.

The university, building on the success of the first company in marketing the products, was able to ink licensees with 16 other companies, a number too many said the doctor-manager for a given market which will put many of these licensees out of business.

Recommendations

Some of the learnings obtained by PCHRD's experience acting as a technology licensing office before the Technology Transfer Act of 2009 and today as seen from the developments in HEIs and R&D institutes.

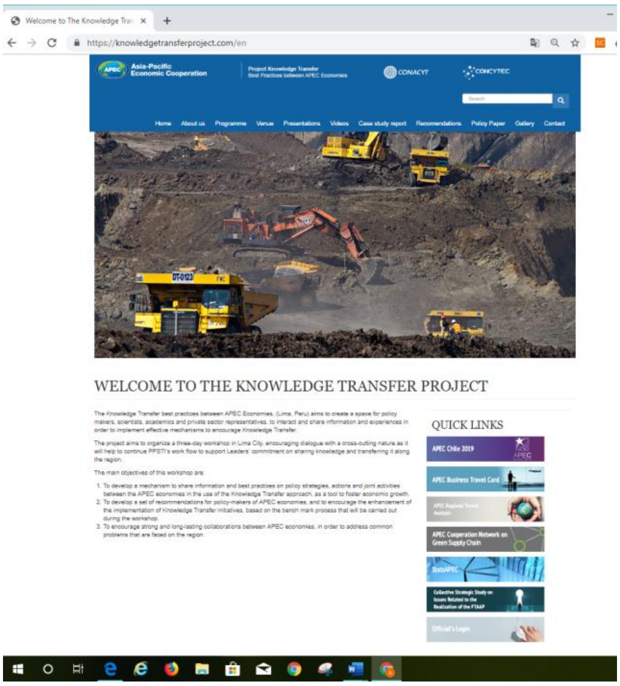
a. Technology transfer is not a program in isolation. It is part of the whole research continuum, where research productivity is high, the chances of transferring knowledge and technologies are high – if in the first place, research is undertaken with the view of solving a problem, with a user base, a market, in mind. Further, one research result may have to be combined with other results to make a viable product, hence, a research will have to undertake with a multidisciplinary lens even at the idea stage.
b. The economy´s research agenda must be defined by the stakeholders, preferably in a bottom-up approach, and balanced with the economy's desire to be in the cutting-edge of science, technology and innovation. This will guide government and other funders in their research investments, including that of developing its critical mass of researchers in chosen fields.
c. Technology commercialization is supported by other equally important strategies of knowledge translation – communicating research, translating research results to policies, organizing research information, e.g., databases, among others.
d. Knowledge translation and technology transfer is not the work of research organizations and HEIs alone but by the whole innovation system, which includes the IP Offices, National Privacy

Commission, venture capitalists, angel investors, regulatory bodies such as FDA, the departments of trade, industry, finance and development planning, industry itself, etc.

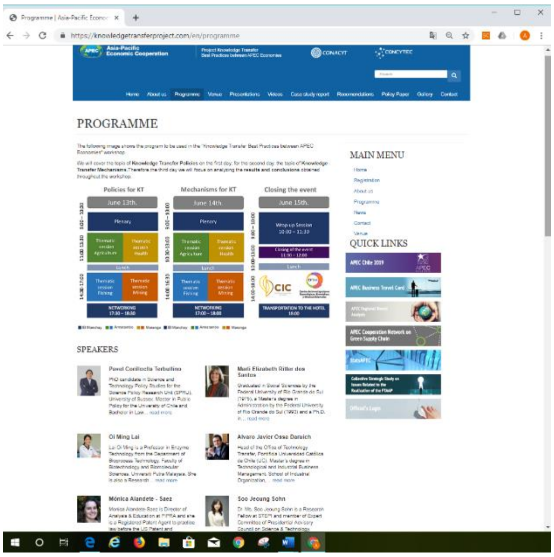
e. The main motivation to transfer technologies is to benefit the public, especially for government-funded researches; secondary would be the return on investment.
f. Trust relationships underpin every technology transfer activity, and the confidence on the work of the economy's researchers.
g. A selection guide is important in choosing the technology adopter putting importance on the core business, integrity and financial capability of would-be adopters.
h. For a sustainable technology transfer, it is important for a economy to foster an investment climate where venture capitalists and angel investors thrive. Where there are gaps in this area, government steps in through programs like the DOST's Science for Change and Technicom.
i. There has to be a platform where research and industry regular meet and inform each other what's happening in the market and in the research community. This is also an opportunity for cross-fertilization – researchers understand how the market works, and industry is able to advise researchers on what the market needs. This interaction may also influence industry to conduct its own research, a state that is sadly lacking to date.
j. Research organizations should set up support systems for IP and technology transfer management, including capacity for technology valuation and setting the optimum number of adopters for a given technology. Government capacity building programs should include support for developing capabilities for managing technology transfer offices. An association or network of technology transfer professionals is important for continuing learning and possible certification programs.
k. Research organizations need to streamline its governance and processes to be nimble enabling speedy actions like setting up of spinoff companies, technology transfer transactions and hedging technology obsolescence.
l. The Technology Transfer Act and other policies must be reviewed to ensure that the private sector is in the loop and observed bottlenecks are removed.

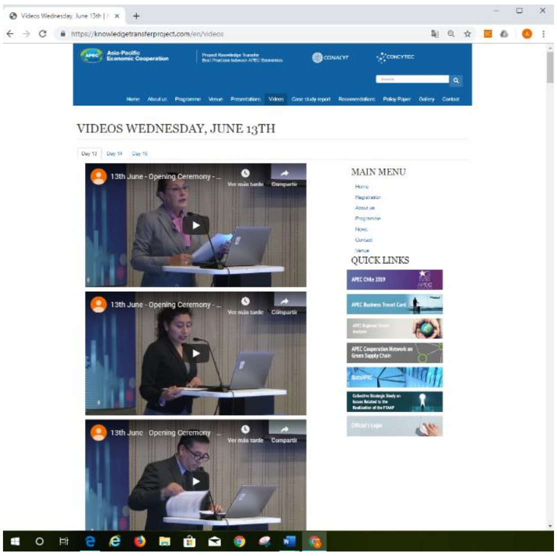
3. WEB: KNOWLEDGE TRANSFER PROJECT

This website has been financed by CONACT for two years since may 2018 to 2020. This is the the principal media for contact during and afther the event. The URL is: https://knowledgetransferproject.com/en Afther these two years the most important content will operate inside CONCYTEC's website.



The sections of the web are: Home, about us, programme, venue, presentacions, videos, case study report, recommendations, policy paper, gallery and contact.





All the outputs of the workshop are available in the project's website assuring open access to all APEC economies' participants and non-participants. In general terms the website was used for:

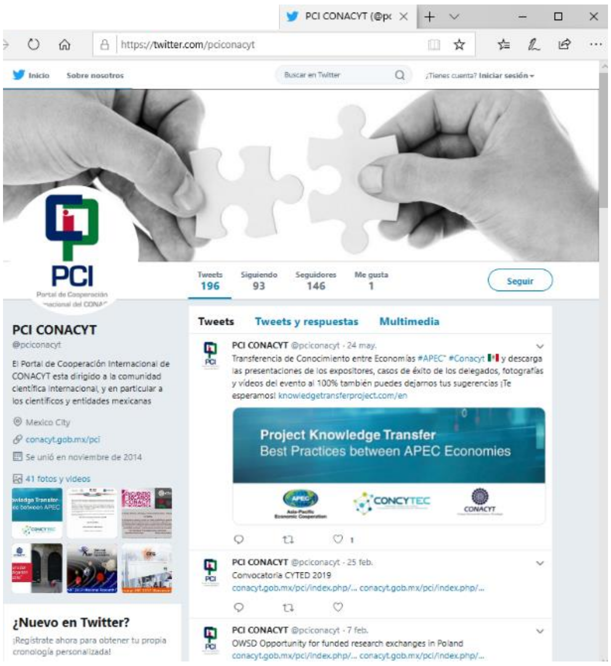
- Arrangements regarding all the logistic necessary: meeting rooms, facilities, food, transportation, accommodation, etc.

- The design, host and launch of a website was performed in order to provide information during the Workshop.
- Final presentations and outcomes of the Project were published through the website (as presentations, successful case reports, videos from all the sessions and photos).

- Obtain general indicators as hits, hits in web tabs (as an indicator of downloaded documents) and views of the photos and videos.

- The registration by the website from all the participants (speakers, delegates, experts, staff and and general public) produced a mailing list wich is used to share the contents produced in the workshop and future events related to technology transfer.

In a complementary way, the social networks of CONCYTEC and CONACYT were also used to disseminate updates on the web before, during and after the workshop.



VIII. Performance Indicators

After concluding the workshop, a survey was carried out. From the results we can highlight that the participants said, for the most part, strongly agree with the content of the event. Especially, regarding the clarity of the objectives of the workshop and the preparation and capacities of the speakers. Some participants pointed out that the gender issue was not sufficiently addressed, this was due to the theme of the event. However, the participation of women and men was quite balanced, except in the case of the general public.

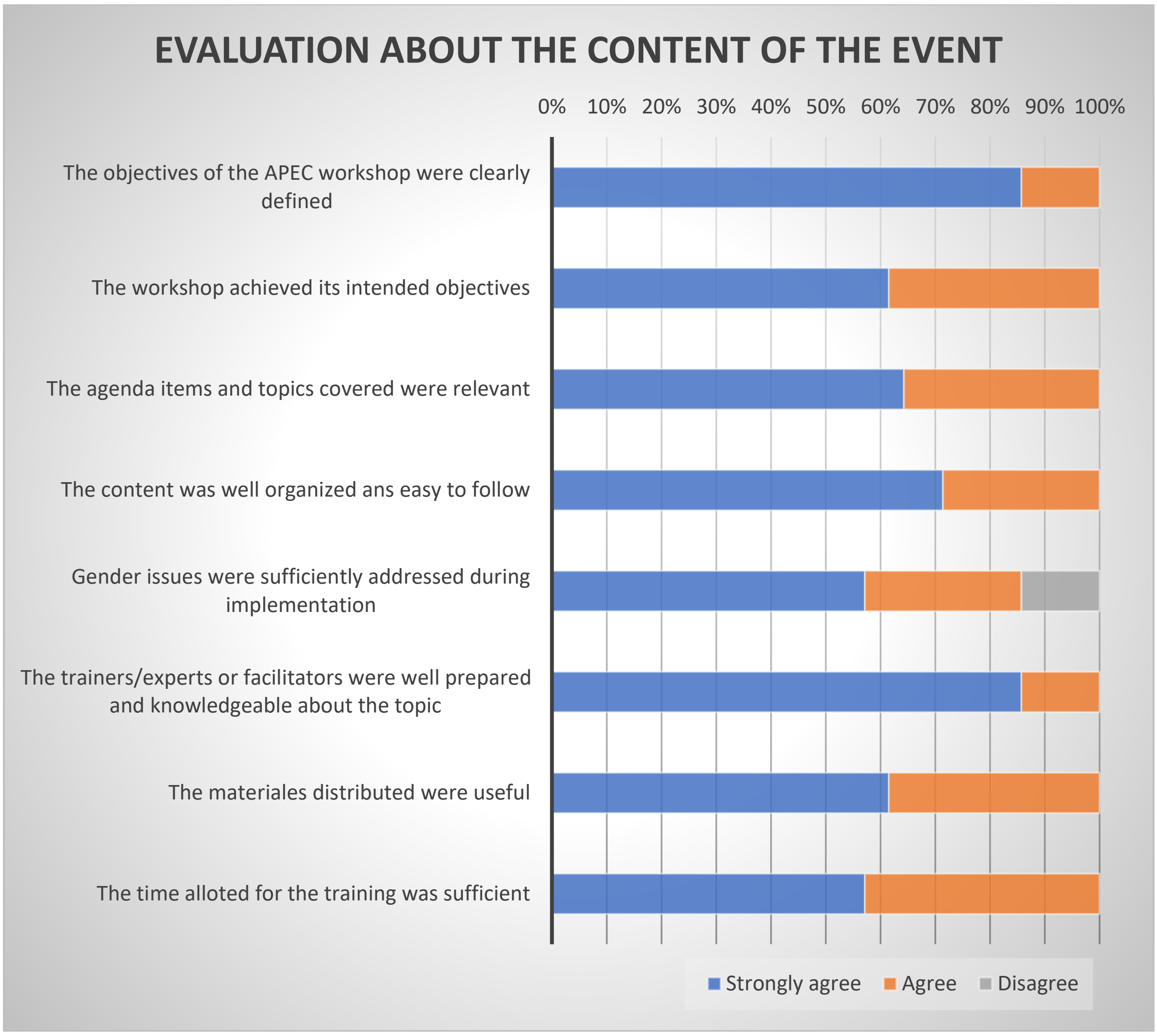
Likewise, the results of the survey show that 57% of the participants considered that the workshop was very relevant for their economy, while 43% considered that the workshop was relevant.
In this framework, one measure of the impact of the workshop was the level of knowledge and skills on the topics covered. Thus, before the event, 24% of the participants indicated that they were at a basic level, 47% at the intermediate level and 29% at the advanced level. After the event no participant was considered within the basic level, of the total 47% in intermediate level and 53% in advanced level.

A priority of PPSTI is to improve the regional connectivity of science and technology, also, two of the objectives of the workshop were to create a mechanism to share information and best practices on policy strategies and encourage solid and lasting collaborations among the APEC economies. In that sense, the presence of diverse actors from academia, industry and government was crucial to foster collaboration. Of exhibitors, experts and delegates, 59% belong to the academy, 25% to the government and 16% to the industry. Therefore, we can affirm that the workshop was a favorable space for connectivity between actors from different areas and economies.

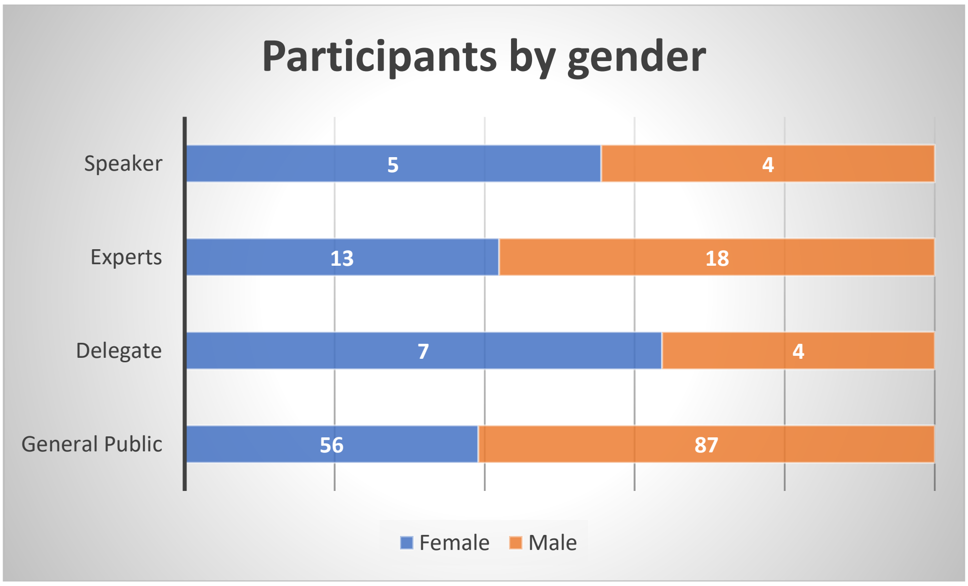
According to the activity report on the project website, during the period 09 / May / 2019 to 29 / May / 2019, the website had 198 users, of which 13% were recurring users and 87% new users. The visits to the website were in total 2255. The downloadable file windows of the 13 presentations and the 9 case study reports had 198 and 201 visits respectively. Likewise, 125 videos were uploaded from the 3 days of the workshop, which in total had 472 reproductions.

1. RESULTS OF THE SURVEY TO THE PARTICIPANTS

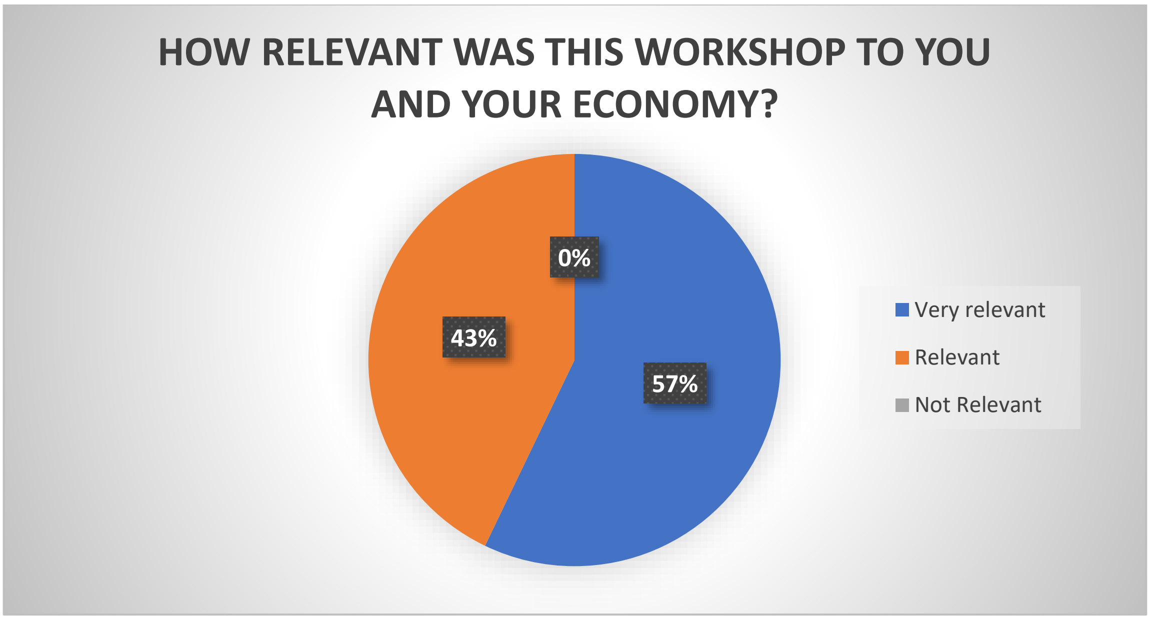
After concluding the workshop, a survey was carried out. From the results we can highlight that the participants said, for the most part, strongly agree with the content of the event. Especially, regarding the clarity of the objectives of the workshop and the preparation and capacities of the speakers.



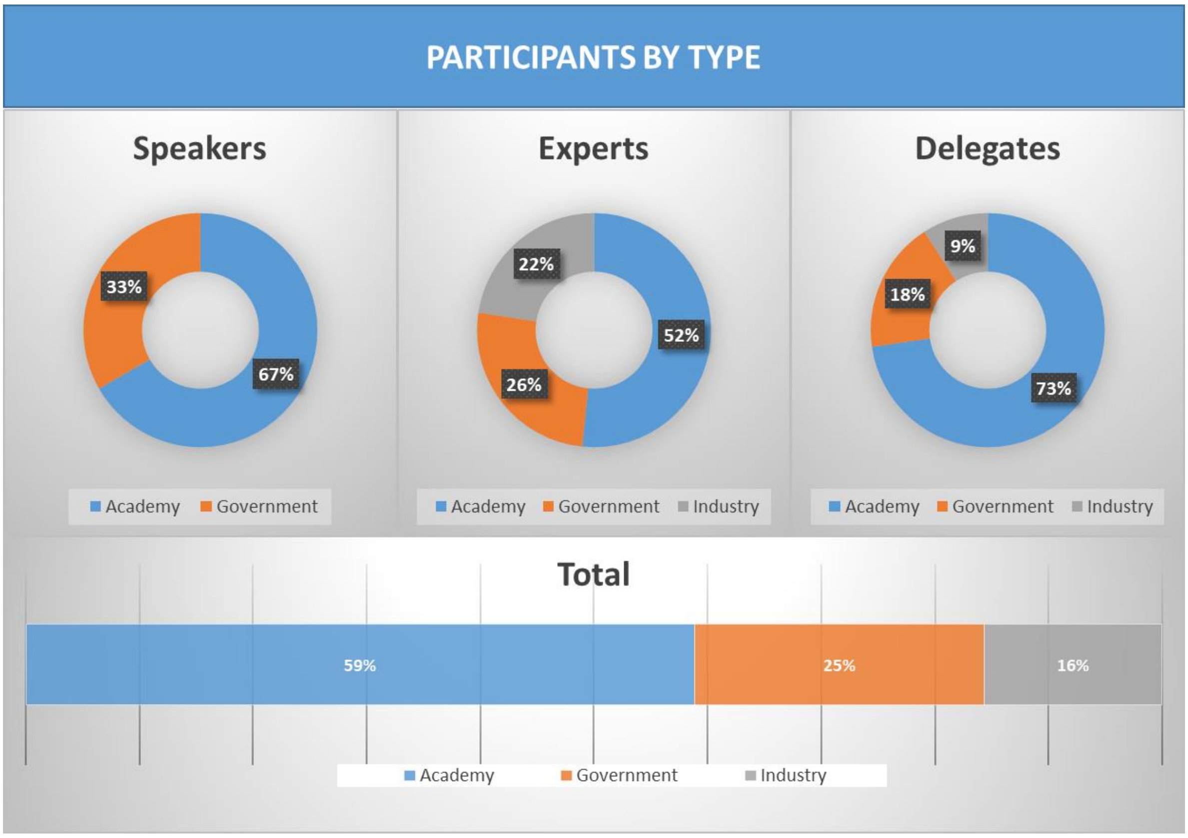
Some participants pointed out that the gender issue was not sufficiently addressed, this was due to the theme of the event. However, the participation of women and men was quite balanced, except in the case of the general public.



Likewise, the results of the survey show that 57% of the participants considered that the workshop was very relevant for their economy, while 43% considered that the workshop was relevant.

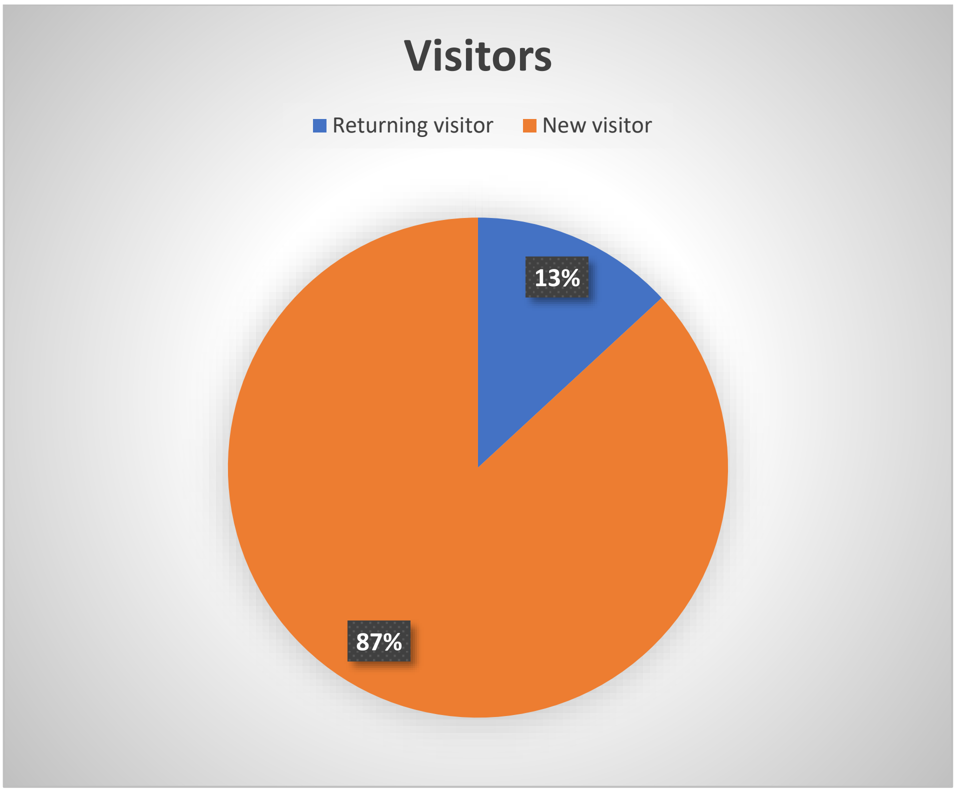


In this framework, one measure of the impact of the workshop was the level of knowledge and skills on the topics covered. Thus, before the event, 24% of the participants indicated that they were at a basic level, 47% at the intermediate level and 29% at the advanced level. After the event no participant was considered within the basic level, of the total 47% in intermediate level and 53% in advanced level.

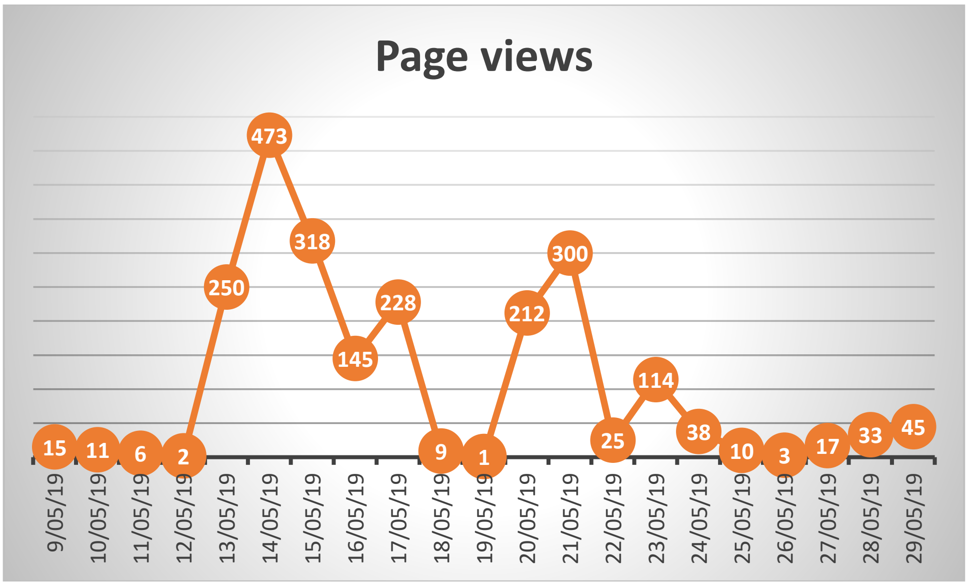


2. ACTIVITY REPORT ON WEB PAGE

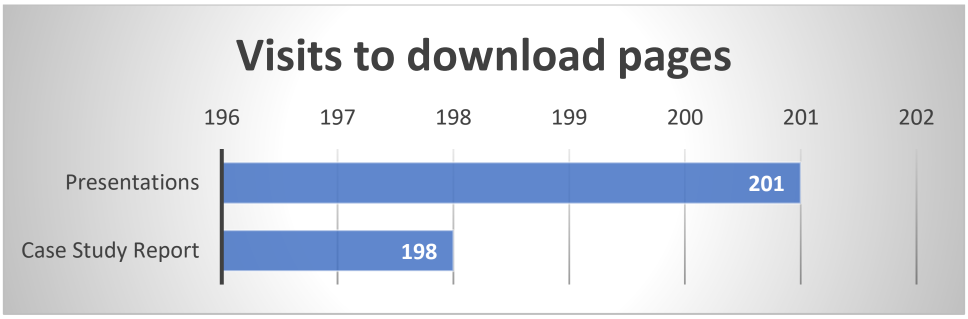
Period: 09 / May / 2019 to 29 / May / 2019
Website: http://knowledgetransferproject.com/en
According to the activity report on the website of the project, during the period indicated, the website had 198 users, of which 13% were recurring users and 87% new users.



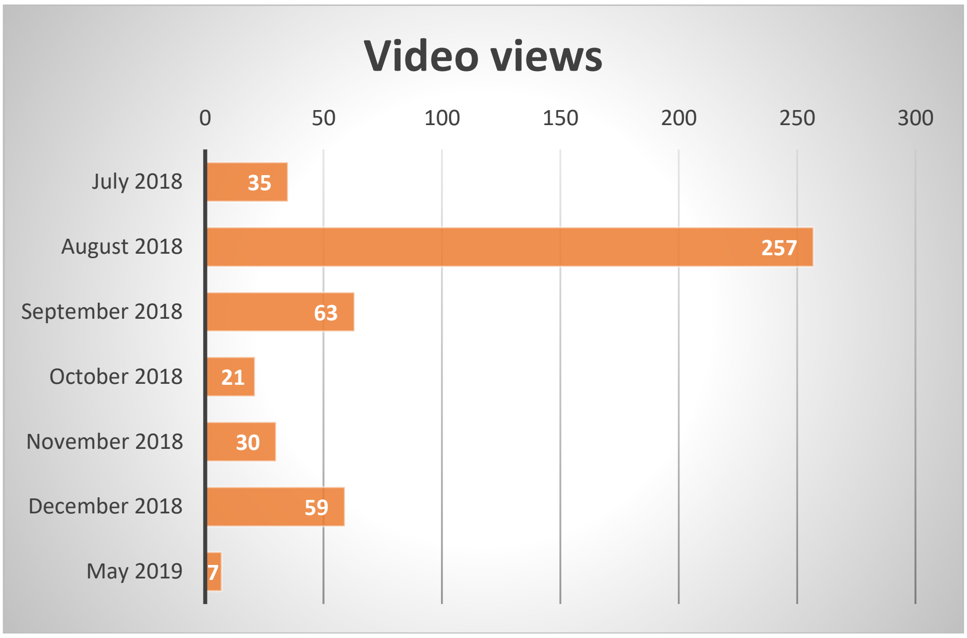
The visits to the website were in total 2255, the trend by date was as shown in the following graph.



The downloadable file windows of the 13 presentations and the 9 case study reports had 198 and 201 visits respectively.



Likewise, 125 videos were uploaded from the 3 days of the workshop, which in total had 472 reproductions, the trend by date was as shown in the following graph.



IX. Workshop Agenda

FIRST DAY (June 13 Th)		
Opening Session		
9:00 - 9:40	**Opening ceremony** Fabiola León - Velarde, President of Concytec Gloria Valencia Mejia, International Cooperation Adviser – Conacyt Jose Bustinza Soto – Director of APEC and Specialized Forums - Ministry of Foreign Affairs	
Plenary Session: Policies to promote knowledge transfer		
9:40 – 10:30	**Plenary presentation: Policies to promote knowledge transfer: past, present, and future – Manchay Room** PhD (c). Pavel Corilloclla, Doctoral Researcher in Science and Technology Policy Studies - SPRU Science Policy Research Unit - University of Sussex - United Kingdom	
	Discussion	
10:30 – 11:00	COFFEE BREAK	
Thematic Session: Policies to promote knowledge transfer applied to agriculture, aquaculture, mining, and health sector		
11:00 – 13:30	**KT in agriculture sector – Armatambo Room**	**KT in health sector – Maranga Room**
	Thematic presentation: Policies to promote knowledge transfer in the agriculture sector Dr Mónica Alandete - Saez, Director Analysis & Education Public Intellectual Property Resource for Agriculture - UC Davis	**Thematic presentation: Policies to promote knowledge transfer in the health sector** Dr Marli Elizabeth Reatter Dos Santos, Technology Transfer Advisor Pontifícia Universidade Católica do Rio Grande do Sul
	Discussion Session	**Discussion Session**
	Conclusions	**Conclusions**
13:30 – 14:30	LUNCH TIME	

14:30 – 17:00	**KT in aquaculture sector – Armatambo Room**	**KT in mining sector – Maranga Room**
	Thematic presentation: Policies to promote knowledge transfer in the aquaculture sector MSc Daniela Hurtado Centeno, Directorate of Policies and Fishery Development Production Ministry	**Thematic presentation: Policies to promote knowledge transfer in the mining sector** Dr Alvaro Ossa Daruich, Head of Office of Knowledge Transfer and Development Pontificia Universidad Católica de Chile
	Discussion Session	**Discussion Session**
	Conclusions	**Conclusions**
17:00 – 17:30	**COFFEE BREAK**	
17:30 – 18:00	**Plenary presentation: Policies to foster and promote the STI System in China – Manchay Room** Dr Ma Leju, Senior expert International Industries Study Team, DiDi	
	Discussion	
18:00 – 18:30	**Network session – Manchay Room** Dr Alvaro Ossa Daruich, Head of Office Office of Knowledge Transfer and Development - Pontificia Universidad Católica de Chile	
	Discussion	

<table>
<tr><th colspan="3">SECOND DAY (June 14 Th)</th></tr>
<tr><td colspan="3">Plenary Session: Mechanism to an effective knowledge transfer</td></tr>
<tr><td rowspan="2">9:00 – 10:00</td><td colspan="2">Plenary presentation: Mechanisms to an effective Knowledge Transfer: current and new tools for KT – Manchay Room
Dr Soo Jeoung Sohn, Associate research fellow in the Industrial Technology Strategy Research Division Science & Technology Policy Institute (STEPI) - Korea</td></tr>
<tr><td colspan="2">Discussion</td></tr>
<tr><td>10:00 – 10:30</td><td colspan="2">COFFEE BREAK</td></tr>
<tr><td colspan="3">Thematic Session: Mechanism to an effective knowledge transfer applied to agriculture, aquaculture, mining, and health sector</td></tr>
<tr><td rowspan="4">10:30 – 13:00</td><td>KT in agriculture sector – Armatambo Room</td><td>KT in health sector – Maranga Room</td></tr>
<tr><td>Thematic presentation: Mechanism to an effective knowledge transfer in the agriculture sector
Dr Mónica Alandete - Sáez, Director Analysis & Education
Public Intellectual Property Resource for Agriculture - UC Davis</td><td>Thematic presentation: Mechanism to an effective knowledge transfer in the health sector
Dr Marli Elizabeth Reatter Dos Santos, Technology Transfer Advisor
Pontifícia Universidade Católica do Rio Grande do Sul</td></tr>
<tr><td>Discussion Session</td><td>Discussion Session</td></tr>
<tr><td>Conclusions</td><td>Conclusions</td></tr>
<tr><td>13:00 – 14:00</td><td colspan="2">LUNCH TIME</td></tr>
</table>

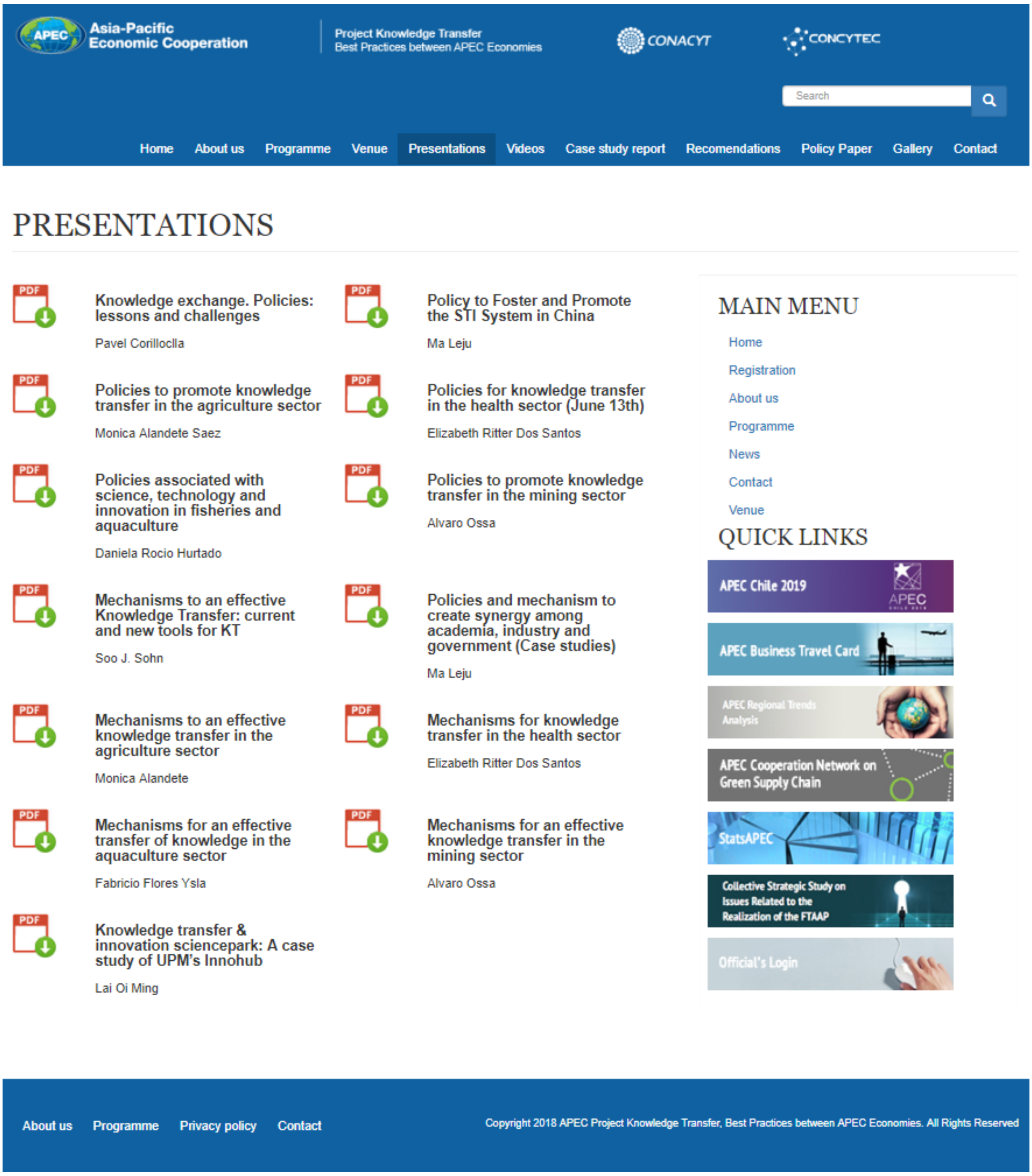
14:00 – 16:30	**KT in aquaculture sector – Armatambo Room**	**KT in mining sector – Maranga Room**
	Thematic presentation: Mechanism to an effective knowledge transfer in the aquaculture sector MSc Fabricio Flores Ysla, Head of the Aquaculture Innovation Unit. National Program for innovation in fisheries and aquaculture	**Thematic presentation: Mechanism to an effective knowledge transfer in the mining sector** Dr Alvaro Ossa Daruich, Head of Office of Knowledge Transfer and Development Pontificia Universidad Católica de Chile
	Discussion Session	**Discussion Session**
	Conclusions	**Conclusions**
16:30 – 17:00	**COFFEE BREAK**	
17:00 – 17:30	**Plenary presentation: Policies and mechanisms to create synergy among academia, industry and government – Manchay Room** Dr Ma Leju, Senior expert International Industries Study Team, DiDi	
	Discussion	
17:30 - 18:00	**Network session – Manchay Room** Public Intellectual Property Resource for Agriculture - UC Davis Dr Mónica Alandete - Sáez, Director Analysis & Education	
	Discussion	

THIRD DAY (June 15 Th)	
Wrap Up Session	
9:00 - 10:00	**Successful Cases: Knowledge Transfer & Innovation Sciencepark: A Case Study of UPM's Innohub – Manchay Room** Dr Oi Lai Ming, Member of the UPM's Intellectual Property Evaluation Committee Universiti Putra Malaysia - Putra Science Park
	Discussion
10:00 – 12:30	**Summary of the event and preliminary policy recommendations – Manchay Room** Henry Harman Guerra, Director of S,T&I Policies and Programs Concytec Luis D Stefano Beltrán Professor / Researcher at the Genomics Unit Universidad Peruana Cayetano Heredia
	Discussion Dr Soo Jeoung Sohn, Science & Technology Policy Institute (STEPI) Dr Lai Oi Ming, Universiti Putra Malaysia - Putra Science Park Dr Alvaro Ossa Daruich, Office of Knowledge Transfer and Development - Pontificia Universidad Católica de Chile Dr Mónica Alandete - Saez, Public Intellectual Property Resource for Agriculture - UC Davis Dr Marli Elizabeth Reatter Dos Santos, Pontifícia Universidade Católica do Rio Grande do Sul PhD (c). Pavel Corilloclla, Science Policy Research Unit - University of Sussex - United Kingdom
12:30 – 13:00	**Closing ceremony**
13:00 – 14:00	LUNCH

X. Presentations

The presentations can be found in the website project:
https://knowledgetransferproject.com/en/presentations

Adittionaly, you can find all the materials generate in the Workshop. It include list of speakers, agenda, presentations, videos, pictures, and reports (Policy Recommendations to Promote Knowledge Transfer and Successful Cases in Knowledge Transfer).



XI. Speakers and delegates

Speakers

Name	Title (Mr/Ms/Dr/Prof)	Gender	Position	Organisation	Economy	Email
Ma Leju	Dr	Male	Senior expert	International Industries Study Team, DiDi	People's Republic of China	maleju@126.com
Soo Jeoung Sohn	Dr	Female	Associate research fellow	Industrial Technology Strategy Research Division - Science & Technology Policy Institute.	Korea	sjsohn@stepi.re.kr
Alvaro Javier Ossa Daruich	Dr	Male	Head of Office	Knowledge Transfer and Development Office - Pontificia Universidad Católica de Chile	Chile	aossad@uc.cl
Mónica Alandete - Saez	Dr	Female	Director of Analysis & Education	PIPRA - UC Davis	The United States	malandete@ucdavis.edu
Marli Elizabeth Ritter dos Santos	Dr	Female	Technology Transfer Advisor	Pontifícia Universidade Católica do Rio Grande do Sul	Brazil	elizabeth.ritter@pucrs.br
Lai Oi Ming	Dr	Female	Professor and Research Fellow	Putra Science Park, Universiti Putra Malaysia (UPM)	Malaysia	omlai.biotech@gmail.com
Pavel Corilloclla Terbullino	Dr	Male	Doctoral Researcher	Science Policy Research Unit - University of Sussex - United Kingdom	Peru	P.Corilloclla-Terbullino@sussex.ac.uk
Daniela Hurtado Centeno	MSc	Female	Specialist	Directorate of Policies and Fishery Development, Production Ministry	Peru	dhurtado@produce.gob.pe
Fabricio Flores Ysla	MSc	Male	Head of the Aquaculture Innovation Unit	National Program of Innovation in Fisheries and Aquaculture	Peru	fflores@pnipa.gob.pe

Delegates

Name	Title (Mr/Ms/Dr/Prof)	Gender	Position	Organisation	Economy	Email
David Molina Concha	MSc	Male	Technological Transfer Hub Executive	Economy Development Agency - CORFO	Chile	david.molina@corfo.cl
Etienne Choupay	MSc	Male	Projects and Technology Transfer Coordinator	Innovation Division - Ministry of Economic, Development, and Tourism of Chile	Chile	echoupay@economia.cl
Zhu Junqiao	MSc	Female	Manager of Scientific Research Institute	Scientific Research Institute - Zhejiang Normal University	People's Republic of China	674720645@qq.com
Ye Jiaolong	MSc	Female	Engineer at Sichuan Institute of Nuclear	Engineering and Technology Research Center - Sichuan Institute of Nuclear	People's Republic of China	yjl051766@163.com
Aini Suzana Ariffin	Dr	Female	Head of projects on entreprenurship and technology commercialization	Perdana School of Science Technology Innovation Policy-University Technology Malaysia	Malaysia	aini.suzana@yahoo.com ainisuzana@utm.my
Zakwan bin Azahari	MSc	Male	Under Secretary of Human Resource Management Division	Ministry of Agriculture & Agro-based Industry Malaysia	Malaysia	zakwan@moa.gov.my
Patricia Ocampo-Thomason	Dr	Female	Technologist, director Southeast Unit	Center for Research and Assistance in Technology and Design of the State of Jalisco	Mexico	pocampo@ciatej.mx

América Padilla Viveros	MSc	Female	Head of Knowledge Commercialization Agency	Center for Research and Advanced Studies	Mexico	aviveros@cinvestav.mx
Thininut Srichan	MBA	Female	Director of Biotechnology Business Development Division	National Center for Genetic Engineering and Biotechnology	Thailand	Thininut.sri@biotec.or.th
Julius Caesar Sicat	Dr	Male	Regional Director	Philippines' Department of Science and Technology	The Philippines	jaycee_sicat@yahoo.com dostregion3@hotmail.com
Merlita Opeña	Dr	Female	Chief Science Research Specialist	Philippines' Department of Science and Technology	The Philippines	mmopena@pchrd.dost.gov.ph