รายงานประจำปี 2563

Annual Report 2020

Contents

Message from the Governor

Thailand Institute of Scientific and Technological Research (TISTR) is a state enterprise that has missions on the conduct of research, technology transfer, industrial services and creation of innovation under the Ministry of Higher Education, Science, Research and Innovation (MHESI). It is a leading agency in Thailand with excellent potential in research and development, technology transfer and provision of science and technology (S&T) services. With more than 500 quality researchers and experience in various fields as well as 57 years of establishment, TISTR have been conducting more than 2,000 research and development projects in different subjects, knowledge and technologies. Well equipped with the S&T infrastructure in providing research, development and innovation services, TISTR is geared to provide S&T services with laboratories and certification bodies accredited up to international standards together with many networks of cooperation both at home and abroad, including government, educational institutions and private sectors. As mentioned above, TISTR is ready to provide the main services in various fields, namely research, consultation, technology transfer, analysis, testing, calibration, quality system certification, and training covering a wide range of industrial courses - food industry, herbs and cosmetic industry, agro-industry, biotechnology industry, clean energy and environment, materials innovation industry, and automatic machinery industry that respond to both economic, business and social sectors.

In the year 2020, TISTR operated under 4 guiding strategies: 1) Applying technology and innovation for commercial use 2) Developing the economy, community and area through science, technology and innovation (STI) 3) Developing entrepreneurial potential with TISTR innovation infrastructure through One Stop Service Solutions and Digital platform, and 4) Managing innovative technology in marketing and communication to make TISTR a high-performance organization. Of these 4 strategies, important research and development projects have emerged, for instance,"Thai Cosmetopoeia", - to drive the economy of Thai society by increasing cosmetic values according to local identity; "Biogas production using Lignocellulosic from cassava pulp from the production process of ethanol and sweet sorghum" the prototype project to generate electricity from waste and biomass to meet the BCG Model; "Royal Rainmaking Alternative Project"- to increase the efficiency of Royal Rainmaking Operations to maximize water management for utilization; "Gantry robot-type automatic control"- the development of sampling system for raw materials in the agriculture which is the device firstly ever developed to automatically collect samples without manual control and randomize the quality of raw materials in the production process to increase efficiency and at the random sampling point to prevent adulteration; and research on biofuel production and value-added products and by-products from the ethanol industry in development of the continuous-bio-ethanol-based biojet production processes with microtechnology.

In addition to operating under the concept of "Partner for your success", TISTR has network partners that cooperate in extensively applying our research and development work and services. These collaborative projects were, for example, research, development and performance testing of health and medical equipment and products with Siriraj Hospital to strengthen the integrated cooperation between TISTR and Siriraj in supporting, promoting and strengthening product research, development and testing for health and medicine; cooperation with the National Housing Authority in innovative management for sustainable development; cooperation with customers from the private sector who had been transferred of TISTR's technologies such as Vitristra anti-aging and facial rejuvenation cosmetics, Tamarina Nano Serum for skin brightening, MDmate for brain nourishment, in promoting these commercial products at TV Channel 9 MCOT HD; cooperation with various regions in Thailand such as, Kanchanaburi province - in the operation of STI under the concept of Circular Economy of agricultural waste material project according to the BCG Model policy; Phrae province - concerning the wild Mycorrhizal Mushroom Project for forest restoration and alternative food sources and income generating of the community; Loei province - related to tissue culture, product processing, plant pots from local materials, and the production of household organic fertilizers; Chiang Rai province - guidelines for the production of Refuse Derived Fuel (RDF), etc. There were also other types of cooperation with many foreign

organizations such as WAITRO (World Association of Industrial and Technological Research Organizations), JAIMA (Japan Analytical Instruments Manufacturers Association) to exchange knowledge of national regulations on the latest analytical tools and their applications including issues relating to herbs for food supplements and cosmetics, etc.

Concerning testing, analysis and calibration services, TISTR was successful in project of the Development, Analysis and Testing of High-speed Rail Systems. So far, we are ready to be a support agency for research and development in testing and certification of rail transportation products for safety and to meet international standards. There was also a project to develop testing biodegradable products up to international standards and to provide biodegradation testing services to be certified in accordance with ISO / IEC17025 international standards covering all products affecting the environment according to the regulations of the partner countries of Thailand. In aspects of product quality, TISTR conducted research and development of herbal extract manufacturing technology to meet international standards and we are ready to raise the laboratory standard to be certified of ISO / IEC 17025 (Methods for Substance Quality Control) as well as raising the laboratory standard for alternative safety testing of extracts and cosmetic products to meet the OECD standard- GLP. Moreover, in the situation of the the new coronavirus or Covid-19 pandemic, TISTR offered our expertise in STI in testing Negative Pressure rooms for Airborne Infection Isolation Room (AIIR) at Siriraj Hospital in order to prevent the spread of infection from the patient to other areas in the hospital.

In 2020, TISTR achieved various rewards, namely, the Recognition of Excellence award for government agencies that perform the mission of enhancing sustainable self-reliance of SMEs potential with STI that also geared Thai society towards Thailand 4.0; Gold Medal / Special Prize on Stage from Seoul International Invention Fair 2019 for research work entitled “High-Performance Micro-Capsule Polymer for Enzyme Recycling: Innovative Polymer Micro Capsule for Enzyme Recovery.” In addition, TISTR was proud to receive the awards for organizational management which comprised: the Sakerat Environmental Research Station’s national G-Green logo plaque, and the award “Digital Government Awards 2019”, The Winner Award in the Digital Entrepreneur Awards Program, which is one step of the Digital Transformation undertaken by TISTR.

The mentioned achievements and awards represent 57 years of success that TISTR are confident to move forward, continuously bringing research and development and STI services to enhance competitiveness of industrial and business sectors, and to increase value both in terms of the economy and society of the country. Last but not least, our work shall yield benefit to both people and the country in times of crisis, supporting them to adapt and move on in the midst of changes and difficulties in the New Normal situation with strength and sustainability.

Dr.Chutima Eamchotchawalit
Governor of Thailand Institute of Scientific and Technological Research

Board of TISTR

Dr. Pasu Loharjun
Board Chairman
(18 Nov 2019-Present)

Prof. Sirirurg Songsivilai
Board Member
(30 Dec 2016-30 Sep 2020)

Ms.Duangjai Asawachintachit
Board Member
(1 Oct 2017-Present)

Dr. Thosaporn Sirisumphand
Board Member
(29 Jun 2018-30 Sep 2020)

Mr. Permsuk Sutchaphiwat
Board Member
(18 Nov 2019-Present)

Flight Lieutenant Kanok Thongpurk
Board Member
(18 Nov 2019-Present)

Mr. Tien-ake Tiyapongpattana
Board Member
(18 Nov 2019-Present)

Ms. Kanittha Sahamethapat
Board Member
(18 Nov 2019-Present)

Miss Nisakorn Jungjaroentham
Board Member
(18 Nov 2019-Present)

Mr. Sakchai Unchittikul
Board Member
(18 Nov 2019-Present)

Dr. Chutima Eamchotchawalit
Board Member and Secretary
(2 Nov 2018-Present)

TISTR Executives

Dr. Chutima Eamchotchawalit
Governor

Dr. Aparat Mahakhant
Deputy Governor
Research & Development Group
for Sustainable Development

Mr. Sayan Tanpanich
Deputy Governor
Research & Development Group
for Bio-industries

Mr. Wirach Chantra
Deputy Governor
Industrial Services Group

Dr. Jittra Chaivimol
Deputy Governor
Administration Group

Dr. Apakorn Supanya
Deputy Governor
Strategies and Innovation
Management Group

Crucial Organizational Business Risks

The changing conditions of business, industry, and other environments have considerable influences on TISTR to face risks in various areas, including strategies, operations, finance, and compliance with regulatory aspects which affects the performance of TISTR in its missions to achieve the goals and objectives. However, in early March 2020, the situation of the Coronavirus 2019 or COVID-19 had affected Thailand and many other countries around the world, namely on safety of people, state restrictions in some areas and travel in order to control outbreaks. This directly had adverse impacts on the economic slowdown and supply chain disruption that continually affected the sales sector of both products and services, resulting in the disruption of business processes and opportunities of customers and stakeholders as well as the performance of the organization

Thailand Institute of Scientific and Technological Research (TISTR) had, therefore, analyzed and assessed risks that could arise and hinder the implementation of the mission of the TISTR as follows:

• Economic crisis caused by the COVID-19 outbreak that has a negative effect on the business operations of the industrial sector and the economic impact through global supply chain. The shortage of labor and raw materials has arisen as the People's Republic of China, which is the world's largest producer and exporter of intermediate goods, has slowed down production according to strict control measures announced by the government, thus having an impact on export sector and related industrial entrepreneurs which is TISTR's important customer group. For instance, many firms have closed or have sold their businesses so TISTR's operations in providing services to the industrial sector fail to meet organizational indicators or do not meet the target.

• Travel restriction measures to control the spread of the virus announced by the government have affected TISTR's operation in transferring of knowledge in Science, Technology and Innovation (STI) and the area-based policy in driving STI for economic, social and environmental benefits for various provinces across the country. The lock-down measure of many provinces would make it impossible for TISTR to carry out the projects as set and achieve the goals. That would cause delays in various projects which could badly affected entrepreneurs, organizations, as well as stakeholders. In this regard, communication plays a key role. If there is a lack of proper communication about the measures enforced, It could lead to the misunderstanding that TISTR did not pay attention to the value of fieldwork for transferring STI knowledge, and stakeholders would have no trust in TISTR, leading to a long-term negative effect that could occur.

• Lifestyle of people in the society has changed as they might be panic and terrified by the spread of the virus so they would keep themselves safe and stay home, not living normally and not going outside as usual. Customers may permanently change some of their consumption behavior, which will have an impact on the mission of TISTR related to raising the standards and competitiveness of the industry through the services in analysis, testing, calibration, quality system certification, training and consulting. The number of customers who contact for using the services may decrease. This definitely results in the reduction of corporate income.

• The government policies on "Stay home, stop infection for the nation" and "social distancing" to tackle crisis as well as control and prevent the spread of the virus which is widely notified in every organization including TISTR that announces a measure for employees to work from home (WFH). However, the risk may take place as some important projects or processes would be disrupted or could not be operated continuously. Therefore, it may have a negative impact on TISTR's reputation, credibility including the loss of opportunity and income.

Business Condition, Business Plan and Strategy

TISTR is a national leading organization with the readiness of resources and potential for research, development, and technology transfer including services in various areas. The strengths of TISTR are as follows :

1. More than 500 researchers with experience in various fields
2. Over 55 years of R&D works, knowledge, and technology, approximately 2,000 works
3. Infrastructure that ready to serve research and development, technology, and innovation.
4. Laboratories and certification bodies accredited to international standards
5. Numerous local and international cooperation networks, including government, education institutions, and private sectors.

Besides, TISTR's main services include research services, consulting services, technology transfers, testing and analysis, quality system certification as well as training. The scopes of training are covering a wide range of industries and serving both economic, business, and social sectors, for instance, food industry, herbal and cosmetic industry, agriculture industry, biotechnology industry, clean energy, and environment industry, material innovation industry, and robotic and automation industry.

TISTR defined target customer in 3 groups as follows :

(1) Government organizations: central / regional / local / state-owned enterprises /public organizations

(2) Private sector: large enterprises and small and medium enterprises (SMEs)

(3) Social/individual sector: community enterprises, farmers, and inhabitants

TISTR has developed and promoted business operations for customers by utilizing driving mechanisms through customer and market strategic plans linked among national strategy, ministry's policy, TISTR's policy, and competitor analysis. The strategic plans are as follows:

Tactic 1

Plan for the commercial use of technology and innovation through integrated marketing communication channels. The institute emphasized pushing forward the utilization of technology, innovation, and research results which commercialized from TISTR. Those works were managed properly by applying Technology Roadmap: TRM, Technology Readiness Level: TRL, Business Model Canvas: BMC, and related certification standards. TISTR applied the technology transfer mechanism for potential entrepreneurs in various economic fields in terms of proactive publicity to disseminate technology transfer works and activities. This publicity aims to build brand awareness and publicize the good image of TISTR for target customers including enhancing the competitiveness of potential entrepreneurs in both the service industry and public and academic sectors.

Tactic 2

Developing local and area-based economy with STI and communicating with the community to create a positive attitude in working together. The plan focused on driving technology and innovation to be used in the economic development of local communities. Moreover, this tactic emphasized on development of marketing activities that are expected to create awareness about the potential of TISTR technology in solving economic/social/environmental problems to effectively help people at the grassroots level. The performance was able to measure through monitoring and evaluating on economic and social impact assessment of the community.

Tactic 3

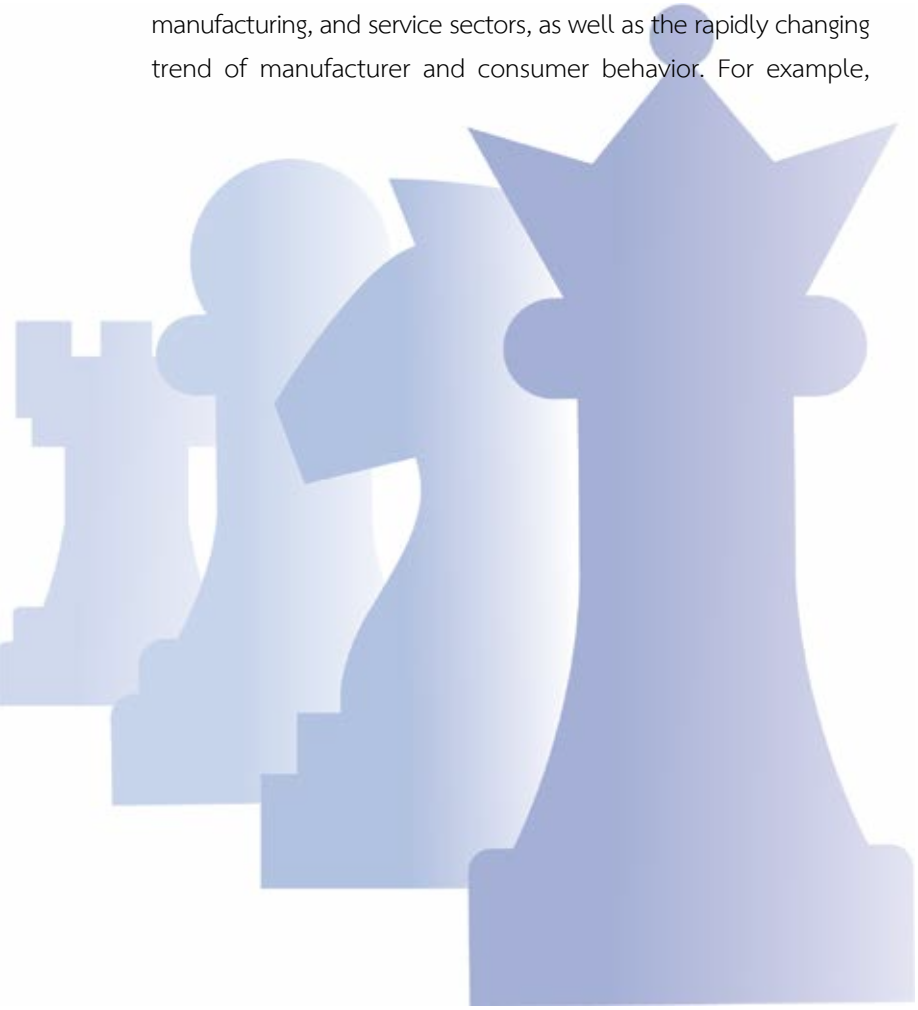
Develop the potential of entrepreneurs with TISTR innovative infrastructure via One-Stop Service Solutions and Digital PR. The main purposes of this tactic were to enhance potential and raise standards of R&D and infrastructure in commercial services and build confidence and reduce the constraints of scale-up, from lab scale to demonstration plant. The plan also provided a full range of industrial services including promoting knowledge of researchers in upgrading production to the manufacturing sector, and building awareness on TISTR's potential of technology and services which support the potential of the target entrepreneurs.

Tactic 4

Management of technological and innovative marketing and communication to make TISTR a high-performance organization. It was a plan that focuses on technology and innovation management of TISTR through related management mechanisms such as the Intellectual Property aspect, analysis of target industry trends consistent with TISTR mission, and communication of innovative technology works to meet expectations of target customers by using marketing tools to explore, collect and analyze trends, needs and expectations of customers in R&D and services from Bio-industries group, Sustainable Development group, and Industrial Services group.

The major competitors of TISTR are government agencies, educational institutions, as well as research/analysis/testing institutes since their main business activities are similar to TISTR. TISTR has adjusted the business model to be Strategic Partner by focusing on networking rather than competition. The model aimed to build collaborative works on R&D and expand the target group of customers. Meanwhile, the private sector could be both customer and competitor. However, in the operations that TISTR can provide effective services, those private competitors can turn to be customers or business networks. Therefore, TISTR's strengths in research, development, and service provision result in a low level of competitor threat. Nevertheless, it is necessary to plan business operations and adapt of Business Model Canvas (BMC) to make those competitors become strategic partners of TISTR and strengthen TISTR competencies on STI.

According to the COVID-19 pandemic, it was one of the uncontrollable factors that affect the economy, investment, manufacturing, and service sectors, as well as the rapidly changing trend of manufacturer and consumer behavior. For example, the global supply chain would be changed to be deglobalization while production and raw material sources may be moved closer to consumers by relying more on local content within the country and region. The reasons for adaptation were to prevent problems from lockdown the country, which will adversely affect the production and distribution of products and services. Also, Work from home (WFH), Learn from home, and Digital transformation trends resulted in a fully digital business and education model. New normal trends of consumers that raise awareness on cleanliness, health, and also affected customer behaviors to rely more on online shopping.



From the pandemic situation, TISTR has adapted to turn the crisis into a market opportunity by developing research and services to respond to customer's needs, presenting outstanding works to reach out to target customers, and creating cooperation network with government agencies, the private sector, and educational institutes in both domestic and international sectors. TISTR was developed new processes including establishing an online system for customer support, customer communication, social support, knowledge provision as well as acted as a mentor and business consultant to clients, in order to build recognition and confidence of customers to TISTR. Moreover, the social media was also utilized to promote an alternative for customer touchpoints.

Highlight Projects

'Thai Cosmetopoeia' Project to Drive Social Economy of Thailand by adding Value Creation of Local Identity to Cosmetics

TISTR has worked with 24 network partners of public and private sectors to drive the social economy of Thailand by adding value creation of local identity to cosmetics, under the project 'Thai Cosmetopoeia'. We have implemented this project in accordance with the National Policies to drive cooperative projects between MHESI and the private sectors, in order to drive bio-based economy with science, technology and innovation, and to return profits to society sustainably.

We have established 10 pilot projects to do research and development of innovative identity cosmetics which are unique and standardized, contained with unique bio-based resources of many localities, by using science, technology and innovation. This project has been implemented in 10 provinces across all parts of Thailand to create practical innovation.

This project builds up a business by combining S&T and unique bio-based resources found in many localities in Thailand, resulting in unique innovation enabling entrepreneurs to create distinctive points to their products or broaden competitive opportunity to their business. The project is based on a principle of 'share value'.

This project has been also implemented in accordance with TISTR's implementation of strategies on research and development in cosmetics 2020, with the concept on STI development of unique bio-based resources found in many localities in Thailand, resulting in the variety forms of cosmetics, to drive social economy in many Thai localities, and to promote Thai local identities in national and international levels. Containing the story-telling of local wisdom, local identities and community economy of particular Thai locality, each cosmetic product has been developed and standardized.

In collaboration with network partners in provincial areas, local business in target areas, major business sectors, research and development sectors, production sectors with GMP standard, financial sectors, marketing sectors, and public relations sectors, this project has promoted these innovative identity cosmetics in national and international levels, further driving economy of Thailand's cosmetic industry, linking to tourism industry, and contributing to the pilot conservation of natural resource and local wisdom sustainably.

The project of cosmetic innovation development from Thai regional unique bio-based resources under the concept on 'Miracle of Beauty: Pruksa to Tararat', selected unique plants from many provinces of Thailand – from the Northern to the Central, and the Central to the Southern Regions – the selected unique plants were put into research and development processes as main crops, then they were transformed into new potential commercials products. Examples of successful development of innovative identity cosmetic products under this project were:

Cosmetic products from Hom, Phrae Province

TISTR and Maejo University Phrae Campus have jointly developed cosmetic products used for daily make up. We have applied product development innovation with specific techniques to create prototypes of 2-in-1 mascara with 100 percent natural color from Hom, used for eyelashes and eyebrows makeup. It is stable and safe to human eyes. Other products include body soap and bath bombs used for body cleaning.

Extract from Tamarind, Phetchabun Province

*** Products of nano serum and nano-gel cream with properties for facial brightening, nourishment and face skin care after laser were developed in the forms of nano-emulsions with small scale in nano-particle level. This product can penetrate the upper skin layer to activate the target cells in the subcutaneous skin layer. Its production technology was transferred to Research X Co. Ltd. and the products were launched into the market.

*** Functional drinking from sweet tamarind, under trade name 'Nature Bright' is the World's first beverage product containing important substances of OPC, discovered in tamarind seeds by TISTR, as the first discovery of the world. The product is certified by Japanese laboratory. The research proves that the substance extracted from tamarind seeds holds antioxidant properties to slow down cell degeneration, and tyrosinase activity inhibitory to hold back melanin production. Obviously, this product holds outstanding anti-aging properties. As it can hold back melanin production, tyrosinaseenzymes contained in this product can whiten human skin. TISTR has transferred production technology to Doctor Service Limited Partnership Company.

*** Mineral drinking product with tamarind extract for customers who exercise regularly. The customers can apply this product before or after their exercises to compensate for the loss of water and mineral, as well as, to prevent the state of oxidative stress caused by excessive free radicals occurring after intense and prolonged exercise. This product already passed safety tests for the cell and animal. Even though having high-volume consumption, there is no any toxicity.

*** Innovation of hydrogel film from tamarind seed powder to cover the wounds can reduce inflammation for oral cavity wound and reduce infection for skin wound.

Facial Care Products from Avocado Extract, Phetchabun Province

TISTR and S&J International Enterprise Public Company Limited have jointly developed facial care products from avocado extract, as raw material from Khao Kho District, Phetchabun Province. The products are effective against free radicals, slow down wrinkles occurrence, and prevent causes of skin pigmentation, under the trade name of 'Mistine' operated by Better Ways Co. Ltd. (Thailand). The products were sold inside and outside Thailand. Raw material of avocado was extracted with specific techniques and passed a safety test to the skin, so as to certify its effectiveness in antioxidants property, slow down wrinkles occurrence, and prevent causes of skin pigmentation. Its products series include serum, eye cream and facial mask.

Cosmetic Product from Natural Mineral Water, Krabi Province

Prototype of cosmetic product for facial skin – developed in the forms of mineral water sprays, skin nourishment serum and sunscreen cream – and body treatment products. Results from analysis, testing and development of salty hot springs showed that salty hot spring contained minerals was beneficial to skin as antioxidants, antibacterial, protect skin moisture, and even better heal skin wounds than aloe. Besides, product effective testing with modern and standard tools of 3D facial skin analysis, e.g. VISIA and ANTERA 3D, shows that, before and after applying the products, these products can reduce wrinkles and smoothen skin tone significantly. After users applied these products, the effective results of salty hot spring cosmetics was obviously seen.

TISTR Received Laboratory Accreditation ISO/IEC 17025 : 2561 from Thai Industrial Standard Institute (TISI), as the First Thai Agency for Railway Systems

The Railway Transportation System Testing Center (RTTC) of TISTR received laboratory accreditation ISO 17025-2561 from Thai Industrial Standard Institute (TISI) to certify laboratory competence in mechanical testing for metal parts, metal products, welding parts of iron, steel and alloy, including railway system works, as the first Thai agency to receive this laboratory competence accreditation ISO 17025-2561 for railway systems, according to the standard BS EN 13230, BS EN 13481 and BS EN 13146, covering products of railway concrete sleepers, railway switches and railway anchors.

RTTC, a unit under Industrial Services Group of TISTR, serving as the central agency for testing services on materials, parts, metal products and railway parts, has received laboratory competence accreditation according to ISO/IEC 17025-2561. RTTC has broaden technical competence, and is able to deliver quality and reliability testing reports with technical accuracy. RTTC is recognized among country members of Asia Pacific Laboratory Accreditation Cooperation (APLAC) and International Laboratory Accreditation Cooperation (ILAC) in terms of technical competency equivalence, national and international trade facilitation, trade barriers mitigation due to redundant testing, and reduction of redundant testing conducted by partner countries.

In 2020, RTTC has received outstanding achievement recognized in national and international levels, namely testing service to 15 railway construction projects of the Ministry of Transport, providing testing service on geo-grids, construction materials (concrete, rubber, composite materials, steel wires, deformed bars, structural steel, pre-stressed steel wires, etc.) railway rubber pads, fasteners, concrete sleepers, switches, tracks, railway welding marks, railway back plate, fastener, level crossing panel, switch rod, mechanic drive bar/pull rod, glass-fiber reinforced epoxy resin conduit for electrical and communication cable, railway bridge component, Overhead Catenary System (OCS), third rail, bogie frame, wheel, axle, bogie cantianer flat wagon, brake shoes, etc. RTTC has also provided testing services to entrepreneurs within region and abroad – Germany, France, Korea, Japan, Australia, Vietnam, Myanmar, Malaysia and Singapore. Moreover, RTTC plans to provide testing services for railway transportation system, such as testing service and development of testing laboratory and inspection of international railway systems, covering medium-speed train systems and high-speed train systems, collaborating with private companies to develop local content industries leveraging standards for public agencies, and conducting R&D works for railway system technologies, such as railway load monitoring systems, rubberusage promotion in railway systems e.g. fastener, under sleeper pad, etc.

100% Durian Odor Lock Packaging for Durian Storage and Delivery

The Thai Packaging Centre of TISTR and Safer Pac Co. Ltd. (Thailand) have successfully researched and developed innovative thermoforming packaging for durian, or '100% durian odor lock packaging', to meet entrepreneurs' and customers' need, to increase value creation to agricultural crops, to open market both national and international levels, including online market for fresh fruits.

TISTR researchers have applied holistic design and development to create odor lock innovative packaging packaging for durian. Many factors are taken into consideration, including convenience for storage and usage, ease of opening and closing, reopening and closing, appropriateness to save durian for the next consumption, good display of beautiful shape of durian on shelf with transparent material design. Therefore, buyers could see the entireproduct of durian.The most important factor is environmentally friendly concern according to the principle of eco-packaging design to make the box stronger with no need to increase the thickness of the plastic sheet. It can completely control durian odor, keeping it just inside the box by using special lock edge that can also prevent moisture from outside to get inside the box.

Safer Pac Co. Ltd. (Thailand) has introduced this packaging structure development to be reproduced and distributed into commercial usage, by using anti-fog PET plastic sheets, to meet more market needs. Its outcome is an odor lock box for durian, or 'ozone box', under the trade name of 'Safer Pac', which is well recognized among the durian wholesalers, retailers and suppliers inside country, available in many retail stores and home delivery service. The durian exporters also meet entrepreneurs' and consumers' demand very well.

Khai Banana Production in KamPhaeng Phet Province 'Shorter and stronger trunk, more closely planting and more frequently yielding'

The Expert Centre of Innovation Agriculture (InnoAg) of TISTR aims to increase high quality and yield volume of Khai bananas, planted in KamPhaeng Phet Province, which are usually damaged by windstorm. We had conducted research and development to reduce trunk height of Kai bananas by planting water mixed with substance at the base of the 4-month Khai bananas, at 5 grams per plant, to control their trunk height growth.It was found that the water could reduce their trunk height at 1 meter approximately.Controlled Khai bananas have shorter and stronger trunk, being able to endure the windstorm better than those uncontrolled. Besides, the control Khai banana could generate yield approximately 10 days faster. Technological cost is at 1 baht per plant.

The fact that the Khai bananas Kamphaeng Phet with short trunk is able to be planted more closely to each other could increase yield volume and money income to the farmers. It also increases the number of Khai bananas as they could be planted with higher numbers in the plantation. Moreover, we had also conducted research and development to increase the size and weight of the bananas by applying some kind of Gibberelin substance to the young bananas twice at one time per week, in concentration a fiftieth part in a million. The cost is at 4 baht per bunch. It was found that the increasing size and weight per yield unit could increase the price and grade of the bananas and could generate more income to the farmers. It also helped conserve the crop identity of Kamphaeng Phet Province.

TISTR joined with private and public partners to leverage Thai agricultural safety standards to international standards for product value creation and consumers' trust building

TISTR focuses on agricultural safety standards to create value to products and build trustworthiness for consumers, by working together with the Federation of Thai Industries, the National Farmers Council, NoBitter Co. Ltd. (safety vegetable farm in the city) to leverage Thai agricultural safety standards to international standards with certification of ISO/IEC 17065 given by the National Bureau of Agricultural Commodity and Food Standards (ACFS).

The Office of Certification Body (OCB) of TISTR has undertaken and rendered services in audit and certification of agricultural products, promoting them to upgrade into organic agriculture and Good Agricultural Practices (GAP), according to ISO/IEC 17065 given by the National Bureau of Agricultural Commodity and Food Standard (ACFS), and is already acknowledged by the Certification Review Committee of ACFS. It also enables agricultural products to get certification on GAP and organic agriculture for edible crops certified by OCB, helping Thai farmers to get international credibility while increasing the value of products in markets and building more confidence of customers in these products. Presently, the consumers and the general public both inside and outside the country have greater awareness on safety and quality of agricultural products.

As a result, the Thai farmers tend to adapt themselves in this transition period by adjusting their agricultural processes to be certified under safety standards such as organic agriculture and GAP, in order to increase value to agricultural products. For the future projects, OCB plans to expand their audit and certification services from organic agriculture product standards to IFOAM standards, including other international standards, with the aims to enhance the manufacturers to export their products to the global market and to drive the national agricultural sector to be recognized internationally.

Technology Transfer Centre to Increase Productivity and Value to Community Field Crop (Pineapple), Prachuap Khiri Khan Province, Received GMP Standard

TISTR's Technology Transfer Centre to increase productivity and value to community field crops (pineapple), Prachuap Khiri Khan Province, has received GMP standard from the Central Laboratory Co. Ltd. (Thailand) in the scope of pineapple packaging processes according to agricultural product standards on 'Good Manufacturing Practice for Packing House of Fresh Fruits and Vegetable' TAS 9035 – 2553. The centre focuses on applying principles of GMP, covering agricultural product standards for fresh pineapples packaging, starting from receiving raw materials, preparing, selecting, trimming, cleaning, packaging to prevent the product damage, storage to ensure safety and quality of the products, including well-hygiene management of the final state of products.

Also, this centre is one of technological infrastructures of share service operated by TISTR, to converse the processing products from local resources into the quality products, whereas, to conserve the identity of the products according to the local culture, by applying innovation, wisdom, technologies and creations. It aims to generate income to people in the local communities, to promote accessibility to the ready-to-use technologies, to develop and leverage quality and standard to the products, to enhance good partnership and network management to join together the production groups or distribution groups, to connect the groups to the research funding sources, and to increase market channels both domestic and international market opportunities.

Apart from technology transfer works, we have worked by applying science, technology and innovation to leverage entrepreneurs' potential and local and communities' levels, in the forms of development of technological infrastructure to promote agricultural product

processing and upgrade export agricultural crops. It can add value to important agricultural crops in particular province or the region, to enable the farmers and the entrepreneurs to access to processing and production technologies, and to minimize a risk for the farmers and the entrepreneurs, who are not ready to invest in their own production site or basic infrastructure, at the first stage of their business.

As Thailand's first modern fresh fruit packing plant, this centre has fresh-pineapple-production potential for export to overseas. With its production capacity at 3 tons per hour and complete range of processing machines, this center could be also further applied for other kinds of fresh fruits production in particular areas.

Moreover, it has played an advisory role for the farmers at the upstream level and built confidence for the entrepreneurs at the downstream, concerned crop standard purchased from the farmers. It deems as a medium to expand cooperation linkage among various agencies, to leverage R&D works and agricultural and technological infrastructure in pineapple cultivation sites, and in the long term, to empower the framers to negotiate with the middlemen, so that they could earn more income in the future.

Demonstration Plant for Electricity Generation from Waste and Biomass 'Biogas production from Biomass types of Lignocellulosic from cassava waste from ethanol production and sweet sorghum'

The Expert Centre of Innovative Clean Energy and Environment (InnoEn) of TISTR has received research funding granted by Thailand Science Research and Innovation (TSRI) and Supply Energy Management Co., Ltd. TISTR, as one of the public agencies on the list of biogas consultation agencies, collected by Energy Policy and Planning Office (EPPO), Ministry of Energy, has continuously developed knowledge and technology on biogas production from biomass type of Lignocellullosic from cassava waste from ethanol production using sweet sorghum and industrial waste from ethanol production plants, by using semi-commercial reaction tank with 600 m^3 size It can generate electricity power from biofuels limited up to 300 kW, further develop from biogas technology platform and Anaerobic Phased Solids (APS) technology, according to the research development plans on biogas technology for agricultural waste and energy crops, including the study of new biomass raw materials with commercial potential.

Alternative Rain Substances Enhancing the Royal Artificial Rain Project

With financial support by Agricultural Research Development Agency (ARDA), the Expert Centre of Innovative Materials (InnoMat) of TISTR, and Department of Royal Rainmaking and Agricultural Aviation, has successfully developed alternative rain substances used for artificial rain production. The substance works as a cloud-condensing core to enhance rain cloud reformation based on relative humidity at below 60 per cent, working better than traditional rain substance. The project can increase the successful chance of rainmaking, in order to solve a problem of water shortage and enhance good water management, effectively increasing rainfall in the summer season.

Gantry Robot with Sampling System for Raw Materials in Automatic Controlled Type used in Agro-Industries

The Expert Centre of Innovative Industrial Robotics and Automation (InnoRobot) of TISTR has developed a gantry robot with sampling system for raw materials in automatic controlled type, as the World's first machine to collect raw material sampling automatically – without human control. The machine is used to do random quality control of raw materials to increase efficiency in production processes, to prevent contamination and save time and labor consumption. Also, the machine can do random quality control with 7 checkpoints in the automatic system, as well as to classify the types of trucks by moving their two axes in horizontal direction, these axes can be angled to each other at 90 degrees, covering the area of the tracks. This innovation has continuously developed to cover the target groups.

Featured Activities in 2020

TISTR Signed the MOU of Collaboration with National Housing Authority (NHA) for Innovation of Sustainable Development

Dr. Chutima Eamchotchawalit Governor of TISTR and Mr.Tachapol Kanchanakul, Governor of NHAsigned a Memorandum of Understanding (MOU) for Innovation of Sustainable Development for the period of 2-year collaboration to promote innovative society in the organization, capability development to create and use of innovation for sustainable development, exchange of personnel and knowledge sharing, including scientific cooperation on trainings and academic activities. The signing ceremony was organized on 11 October 2019 at National Housing Authority (NHA), Bangkok.

TISTR Promoted Technology Transfer on TV Channel 9, MCOT HD

Dr. Chutima Eamchotchawalit, Governor of TISTR, along with the Managing Directors of entrepreneurs who have been transferred of technology by TISTR from research to commercialization namely Cosceutic Innovation Laboratories Co., Ltd. (VITISTRA Product for anti-aging and rejuvenating skin), Research X Co., Ltd. (Tamarina Nano Serum for skin brightening), from Thai Cosmetopoeia, and Anajak Intertrade Co., Ltd. (MDmate Product for brain booster and memory enhancer) were on live show of interview on the topic “TISTR policy on technology transfer for commercialization” on 22 October 2019 at TV Channel 9 Studio, MCOT HD, Bangkok.

TISTR Followed up the Success of Entrepreneurs in Value added Waste on BCG Model

Mr. Sayan Tanpanich, Deputy Governor R&D Group for Bio-industries of TISTR and the team of researchers had a site visit in Kanchanaburi on 5 November 2019 to follow up actions of STI for Circular Economy. Under the project, TISTR empowered to local entrepreneurs in capability on organic fertilizer development from sugar mill residues. The project could create value added business return over 1 million baht per month to Yua Man Pona Ferti-Factory Limited Partnership in Tha Maka District, Kanchanaburi Province.

TISTR Participated in the WAITRO 26th Board-Regional Focal Point (RFP) Meeting in Kasane, Botswana

Dr. Chutima Eamchotchawalit, Governor of TISTR participated in the WAITRO 26th Board - Regional Focal Point (RFP) Meeting during 6-8 November 2019 in Kasane, Botswana. The meeting was to follow up actions of Board members and RFPs under their work plan 2019-2020. TISTR was appointed to be RFP for WAITRO in Asia and the Pacific Region having roles and responsibilities in coordination between members and secretariat in the region, to promote WAITRO recognition, and member recruitment. The meeting also discussed on WAITRO opportunities that year e.g. SAIRA Water Campaign & Innovation Award, Horizon 2020 etc.

TISTR and JAIMA, Japan Hosted the 2nd TISTR and JAIMA Conjoint Conference

Mr. Wirach Chantra, Deputy Governor Industrial Services Group, TISTR presided over the opening of "The 2nd TISTR and JAIMA Conjoint Conference : Application of Herb for Dietary Supplement and Cosmetics" that TISTR and Japan Analytical Instruments Manufacturers, Association (JAIMA) organized jointly on 7-8 November 2019 in Bangkok to be a platform of knowledge exchange in laws and regulations on herbal products, dietary supplement, cosmeceutical products, including advanced analytical tools and instruments.

Opening Ceremony of 'The Blocks', Interlocking Block Building from Mae Moh Power Plant's By-Products

Dr. Chutima Eamchotchawalit, Governor of TISTR, Dr. Apakorn Supanya, Deputy Governor for Strategies and Innovation Management Group, and Mr. Tawatchai Jakpaisal, Deputy Governor - The Electricity Generating Authority of Thailand (EGAT), participated in the opening ceremony of The Blocks on 22 November 2019 at Mae Moh Power Plant, Lampang. The Blocks is the building constructed by the interlocking block made from by-products of Mae Moh Power Plant. The project was to develop a mixture of by-products to value added materials such as interlocking blocks. The project could have production capacity at 1,000 blocks per day. The technology was transferred to communities respectively.

TISTR Organized the Forum on "Mycorrhiza Mushrooms- for Forest Restoration and Community Income"

TISTR organized the forum "Mycorrhiza Mushrooms for Forest Restoration, Food Source, and Generate Community Income" on 25 November 2019 at Maejo-Phrae University, Phrae Province. The meeting was fruitful by knowledge sharing in research to community, experience and concept exchange among funding agencies, research organizations, and agriculturists who have already adopted the technology transfer in wild mushroom cultivation (10 communities in Phrae), and agriculturists in phase 2 to receive the technology transfer (10 communities in Phrae, Nan, and Phayao) in 2020. On that occasion, Mr. Nitiwatchara Sirapokaviroj, Deputy Governor of Phrae presided over the ceremony, and Dr. Aparat Mahakhant, Deputy Governor of R&D Group for Sustainable Development, TISTR was the speaker to the forum.

TISTR Organized the Project on TISTR Volunteer, We Do Good Deeds by Heart

Mr. Permsuk Sutchaphiwat, Chief Inspector General, Ministry of Higher Education, Science, Research and Innovation (MHESI) , as a representative of the Permanent Secretary presided over the project "TISTR Volunteer, We Do Good Deeds The event had the speakers from Royal Volunteer Spirit Program, 904 VorPorRor, presented on the topic of Monarchy and Thailand to increase the volunteer spirit and public mind to help other people in emergency situations. There was introduction on life rescue (CPR), and panel talk on environmental conservation and life quality of communities. The event was held on 28 November 2019 at TISTR Technopolis, Pathum Thani.

TISTR Organized the Seminar on Research Result of Biojet Production for Value added Product and By-products from Ethanol Industry

Dr. Aparat Mahakhant, Deputy Governor of R&D Group for Sustainable Development presided over the seminar to publish research result on biojet production for aircrafts and value added by-products from ethanol industry on 29 November 2019 in Bangkok. TISTR by Expert Centre of Innovative Clean Energy and Environment (InnoEn) implemented on the project "Development of Biojet Production Process from Continuous Ethanol by Microtechnology." The framework of project was to study the component of hydrocarbon of biojet from ethanol in 2 procedures (1) Water removal from ethanol for ethylene production and (2) Oligomerization of ethylene for hydrocarbon component production for biojet. It was for the value added and utilization of ethanol from industrial sector.

TISTR Exhibition on STI for Ornamental Plant Cluster Development in Loei Province

Dr. Chutima Eamchotchawalit, Governor, and Mr. Sayan Tanpanich, Deputy Governor of R&D Group for Bio-industries of TISTR had a site visit and participated in the opening ceremony of the 8th Christmas Festival 2019 on 30 November 2019 in Loei Province. TISTR presented its exhibition on STI for ornamental plants cluster development in Loei Province e.g. plant tissue cultivation, production and processing, planting container made from local material, bio-chemical fertilizer production in household.

MOU between TISTR and Department of Rural Roads on Development and Testing on Traffic and Road Safety Equipment

Dr. Chutima Eamchotchawalit, Governor of TISTR and Mr. Pathom Chaloeywares, Director General of Department of Rural Roads, Ministry of Transport signed the MOU for Development and Testing on Traffic and Road Safety Equipment on 2 December 2019 at TISTR Technopolis, Pathum Thani Province.

TISTR / Chiang Rai Provincial Administrative Organization / Chiang Rai United Club Signed the MOU for the Development on Refuse Derived Fuel (RDF)

Dr. Chutima Eamchotchawalit, Governor of TISTR, Mr. Terdkiat Suksai, Permanent Secretary of Chiang Rai Provincial Administrative Organization, and Ms. Jirapat Yuwawan, Managing Director of Chiang Rai United Club Ltd. signed the MOU on the development of Refuse Derived Fuel (RDF) for value creation in Chiang Rai. Such technology and innovation were to promote converting municipal waste to fuel in Chiang Rai Province. It was help to reduce the use of heat energy. The ceremony was held on 16 December 2019 at TISTR Technopolis, Pathum Thani Province.

TISTR/ Royal Project Foundation Join Hands in Integrated Technical Collaboration for Sustainable Economic, Social and Environmental Development

Mr. Charantada Kannasoot, Privy Councilor, Chairman of the Royal Project Foundation, and Dr. Chutima Eamchotchawalit, Governor of TISTR signed the MOU for cooperation in multi dimensions including economy, society, and environment. On that occasion, General Kampanat Ruddit, Chairman of the Royal Project Foundation, Emeritus Professor Pongsak Angkasith, Executive Director of the Royal Project Foundation, Mr. Sayan Tanpanich, Deputy Governor R&D Group for Bio-industries of TISTR, and Dr. Pongsaton Phapakrangkul, Director of Biodiversity Research Centre of TISTR, Dr. Chana Phromtong, Senior Research Officer, Biodiversity Research Centre of TISTR witnessed to the ceremony on 23 December 2019 at Royal Park Rajapruek, Chiang Mai Province.

TISTR Organized “Green Station : Children to Save the World” on National Children Day in 2020.

TISTR joined hosting the event in Science Roadshow on National Children’s Day 2020. The event of TISTR was “Green Station : Children to Save the World” aiming to inspire the youth in systematic and scientific thinking. There were demonstration and brain exercise activities during 9 – 11 January 2020 at MHESI, Bangkok.

TISTR Press Conference on "Mineral Water Products from Krabi"

Dr. Chutima Eamchotchawalit, Governor of TISTR and Pol Lt Col (Rtd) ML. Kitibodee Pravitra, Governor of Krabi Province joined in the press conference on "Mineral Water Products from Krabi". The project was to support the driving policy of Thai economy by value creation of local cosmetics and Thai Cosmetopoeia. The Expert Centre of Innovative Herbal Products (InnoHerb) of TISTR conducted research and development, testing and analysis on properties of salty hot spring in Krabi Province. It was found that the minerals in hot spring water had properties in anti-oxidation, anti-bacteria, and moisture that could enhance healthy skin. Beside, it was found that the hot spring water helped in healing wound better than aloe vera extract. The press was held on 20 January 2020 in Krabi Province.

Giving Alcohol Gel to Reduce the Risk of COVID-19

Dr. Chutima Eamchotchawalit, Governor of TISTR, Mr. Suthep Panpeng, Managing Director of the SRT Electric Train Company, Mr. Sayan Tanpanich, Deputy Governor of R&D Group for Bio-industries, and TISTR Executives gave 3,000 tubes of alcohol gel to people and tourists to keep their hands hygienic for reducing the risk of COVID-19 The event was on 30 – 31 January 2020 at Suvarnabhumi Airport Rail Link Station.

Distributing new species of chrysanthemum seedling and exhibition of agricultural technology in Udonthani

Dr. Suvit Maesincee, Minister of Higher Education, Science, Research and Innovation (MHESI) accompanied by Dr. Chutima Eamchotchawalit, Governor and the team had a site visit in Udonthani on 17 February 2020 to follow up the project on "Youth Create Nation". The group distributed 1,000 seedlings of new-species chrysanthemum to the young volunteers and farmers. There was also an exhibition of TISTR's Expert Centre of Innovative Agriculture (InnoAg) on how to increase quantity and yield of off-season mangoes and "Seeds of life".

Alliance of Public-Private Partnership between MHESI and Ministry of Transport, Thailand to Raise Standards of Rail Industries in Thailand

Dr. Suvit Maesincee, Minister of Higher Education, Science, Research and Innovation (MHESI) and Mr. Suchart Chokchaiwattanakorn, Vice Minister of Transport witnessed the signing ceremony of MOU between Dr. Chutima Eamchotchawalit, Governor of TISTR and Mr. Sorapong Paitoonpong, Director General of the Department of Rail Transport, together with the top executives of 13 organizations namely Mass Rapid Transit Authority of Thailand (MRTA), Airport Rail Link, BTS Skytrain, Bangkok Mass Transit System Public Company Limited, National Science and Technology Development Agency, Department of Science Service, Thai Industrial Standards Institute, Prince of Songkla University, King Mongkut's University of Technology Thonburi, Naresuan University Suranaree University of Technology, Rajamangala University of Technology Isan KhonKaen Campus Rajamangala University of Technology Thanyaburi, and the Federation of

Thai Industries. The MOU committed all Parties to the development of rail industries in Thailand covering technology transfer, R&D on rail systems and standards, rail system in industries, testings and demonstrations, human resource development to promote capability building on rail system and safety according to the national and international standards, capability building on testing and analysis of rail system and local content production to reduce the import, recruitment new persons expertise on rail system, as well as to provide total solutions on rail system for sustainable of the country. The ceremony was held on 19 February 2020 at the club of Ministry of Transport, Bangkok.

TISTR – Puen Chum Chon Association - Thammasat University Join Hands to Strengthen the Community Enterprise / Model-based Economy Group in driving Map Ta Phut Complex, the pilot city in eco-industrial model, Rayong

Dr. Chutima Eamchotchawalit, Governor of TISTR, Mr. Warit Namwong, President of Puen Chum Chon Association, and Ms. Nuchanat Chantarawuthikorn, Assistant Dean for Student Affairs, Faculty of Commerce and Accountancy, Thammasat University signed MOU of cooperation to promote the development of community enterprise and model-based economy group in Map Ta Phut Complex to be in line with Thammasat Model guidelines in driving of Eco Industrial Town in Rayong province. The project was to promote the coexistence with a combination of local wisdom to innovative products of community enterprises by science and technology, to generate income, develop a strong and sustainable grass-root economy. The ceremony was at Golden City Hotel, Rayong province.

TISTR Held a Celebration of 57th Anniversary of Establishment

TISTR celebrated 57th anniversary with the theme "TISTR New Normal and New Way for Sustainable Development". At the event, Dr. Pasu Loharjun, Board Chairrman of TISTR gave certificate of honor to TISTR benefactors and employees who provided support/made reputation or benefits for TISTR/ or employed over 20 and 30 years. In addition, TISTR gave survival bags to people and community members around Technopolis for alleviating the impacts caused by COVID-19 pandemic. The celebration was on 25 May 2020 at the TISTR Technopolis, Pathum Thani province.

Hand-Over Ceremony of Electric Cars and Charging Stations ; Normal/Quick Chargers for EV from TICA/JICS, Japan

Dr. Pasu Loharjun, Board Chairman of TISTR, Dr. Chutima Eamchotchawalit, Governor of TISTR and Executives hosted the Hand-over Ceremony of 7 EV Cars and 5 Charging Stations ; Normal/Quick Chargers that TISTR received from Japan's Non-Project Grant Aid for Provision of Next-Generation Vehicle (FY2014) of the Government of Japan. It was the implementations by Japan International Cooperation System (JICS) and Thailand International Cooperation Agency (TICA) of Ministry of Foreign Affairs with the aim to promote using of EV cars in governmental institutes. Besides, R&D on new vehicles consuming low energy and be environmental friendly was a flagship for industries. By the EVs and charging station received, TISTR will the appropriate in different locations. Data will be collected for further development of EVs and chargers. The hand-over ceremony was held on 25 May 2020 at TISTR Technopolis, Pathum Thani.

Press Conference on Innovative Packaging for E-Commerce of Fresh Products

Thai Packaging Centre (TPC) of TISTR hosted the press conference on its 3 innovative packaging for e-commerce of fresh products. The newly developed packaging were(1) odor lock for durians, (2) packaging for e-commerce of mangoes, and (3) smart label to detect sulfur dioxide on longans. These innovations could help Thai entrepreneurs in doing e-business of fresh products. The event was held on 2 June 2020 at TPC, Bangkok.

TISTR Gave the Certification of Thai Travelling Standard to 13 Agencies

TISTR by the Office of Certification Body (OCB) gave the certifications to 13 organizations that could pass an evaluation on Thai travelling standards e.g. standard of quality travelling activities and tourist attractions. The certification provided will ensure tourists on standard travelling business and services that meet international standards, and promote image of Thailand as the land of tourists.

TISTR Congratulated the new Minister

Dr. Chutima Eamchotchawalit, Governor of TISTR and executives congratulated on Adj. Prof. Dr. Anek Laothamatas on the occasion that he occupied the new minister of MHESI on 13 August 2020 at MHESI, Bangkok

TISTR Hold an Event "*Mitrephora sirikitiae*, In Praise of the Queen Mother"

Associate Professor Soranit Siltharm, Permanent Secretary of the Ministry of Higher Education, Science, Research and Innovation presided over the opening ceremony "*Mitrephora sirikitiae*, In Praise of the Queen Mother" organized by the collaboration between TISTR and Community Enterprise Promotion Office (OSMEP) to disseminate the works of TISTR in ornamental flowers cluster in 3 provinces, namely Chiang Mai, Loei, and Nakhon Ratchasima Province. The event was held on 8-12 August 2020, Siam Paragon Shopping Center, Bangkok.

The Collaboration with University of the Thai Chamber of Commerce on Human Resource Development for Graduate Students, Entrepreneurs and Research to Commercialization

Dr. Chutima Eamchotchawalit, Governor of TISTR and Assistant Prof.Dr. Thanawat Phonwichai, President of the University of the Thai Chamber of Commerce, signed a memorandum of understanding for human resource development in reskill and upskill to students to meet the demands of labor market. It was to push the research results to commercialization. The MOU was signed at UTCC, Bangkok and will last for 3 years from 11 August 2020.

Minister of Higher Education, Science, Research and Innovation Followed up the Implementation of TISTR under the BCG Policy Framework

Adj. Prof. Dr. Anek Laothamatas, Minister of Higher Education, Science, Research and Innovation (MHESI) and his team visited TISTR on 16 September 2020. On that occasion, Dr. Pasu Loharjun, Board Chairman of TISTR, together with Board Members, Dr. Chutima Eamchotchawalit, Governor, and TISTR Executives welcomed his visit and presented TISTR exhibition on its works on BCG to empower farmers and entrepreneurs of the country.

A Seminar to Disseminate the Study of the Project on Feasibility of Using Genetically Modified Yeast in Ethanol Industry

Dr. Chutima Eamchotchawalit, Governor, presided over the seminar for disseminating the research results on "Project on Feasibility of Use of Genetically Modified Yeast in the Ethanol Industry" funded by Energy Conservation Fund in Thailand. The seminar was honored by Dr. Apiradee Thammanomai, Senior Professional Engineer, Department of Alternative Energy Development and Efficiency (DEDE), and Mr.Pipat Suttiwisedsak, Chief Operating Officer of KTIS BioEthanol Co., Ltd. joining as guest speakers to share knowledge and experience on fuel research. In addition, Dr. Pongsaton Phapakrangkul, Director of Biodiversity Research Centre (BRC) of TISTR presented the research study. The seminar was held on 18 September 2020 at Rama Gardens Hotel, Bangkok.

TISTR Participated in Driving the Logistics System by Science and Technology in the "New Normal"

Associate Professor Soranit Siltharm Permanent Secretary of the Ministry of Higher Education, Science, Research and Innovation presided over the seminar on "Driving the Logistics System with Science and Technology in the "New Normal" organized by TISTR. On that occasion, Dr. Chutima Eamchotchawalit, Governor of TISTR, provided keynote speech both general and in-depth information to entrepreneurs and participants, particularly in the transportation of dangerous goods to allow operators able to prioritize the problems in actual operation, to guide on risk management and risk assessment policies in the future, and to promote the safety of modern logistics systems. The seminar gathered experts to exchange knowledge and provide guidance on solving Thai economic crisis after COVID-19 Including safety in the transportation of dangerous goods, and to increase reliability to the trade partners. Mr. Wirach Chantra, Deputy Governor of Industrial Services of TISTR also participated in the seminar It was held on 22 September 2020 at The Berkeley Hotel, Bangkok.

TISTR received Certification of Accredited Laboratory TIS 17025-2561 from the Thai Industrial Standards Institute

Dr. Chutima Eamchotchawalit, Governor of TISTR received a certificate of accredited laboratory TIS 17025-2561 (ISO/IEC 17025: 2017) from Mr. Wanchai Panomchai, Secretary-General of the Thai Industrial Standards Institute (TISI). The ceremony was attended by Mr.Numchai Skulchoknamchai, President of the Choknumchai Group of Companies, Mr. Krit Niwatphan, Research and Development Manager (Chessey), MINE Mobility Corporation Co., Ltd., Mr. Jit Lewon, Assistant Vice President, Italian-Thai Development PLC., Mr. Louis Vandamme, General Manager, Pandrol (Thailand) Co., Ltd., Mr. Nataphong Pita, Technical Support Manager, VOSSLOH, Mr. Wirach Chantra, Deputy Governor Industrial Services of TISTR, Dr. Anat Hasap, Director of Railway Transportation System Testing Center (RTTC) of TISTR, and the researchers to congratulate this achievement on 24 September 2020, at TISI Building, Ministry of Industry.

Achievement Awards 2020

TISTR Receives Recognition of Excellence Awards

Dr. Chutima Eamchotchawalit, Governor of TISTR, received the Recognition of Excellence prize in Thailand OpenGov Leadership Forum 2019 which was held on 17 October 2019 at Watergate Ballroom A&B, Amari Watergate Bangkok. TISTR was considered as a government agency that performs its key role in enhancing SMEs' potential with Science, Technology, and Innovation (STI) in promoting sustainable self-reliance and enhancing Thai society towards Thailand 4.0.

Digital Government Awards 2019

H.E. General Prayut Chan-o-cha, Prime Minister of Thailand, presented "Digital Government Awards 2019", award of supporting government policy under the project cancellation of the official document copy, to Dr. Chutima Eamchotchawalit, Governor of TISTR. The event was organized by Digital Government Development Agency (DGA) on 30 October 2019 at Santi Maitri Building, Government House, Bangkok. The award was initiated under Thailand Digital Government Readiness Survey Project 2019 which aimed to be a national digital government development database and used as information for preparing plans and policies on enhancing government agencies into digital government at both agency and national levels.

The Winner of Digital Entrepreneur Awards

On 6 November 2019, Dr. Narumol Ruenwai, Director of Digital and Information Office (DIO), TISTR, won the Winner award and received a certificate in Digital Entrepreneur Awards 2019 project in the area of utilization of software technology to develop organizations (Government organizations and state enterprises). The event was convened by the Association of Thai Software Industry (ATSI) at Royal Paragon Hall, Siam Paragon, Bangkok, to honor organizations that use software developed by Thai programmers and consider being a model for the digital economy development of the country.

TISTR Wins Gold Medal Award and Special Prize on Stage from Seoul International Invention Fair 2019

The research paper on "Innovative Polymer Micro Capsule for Enzyme Recovery" received the awards from two events. It was an integrated R&D project under the Partnership Programme in Production of Graduates inMaster's Degree and Doctoral Degree. Research participants of this project consisted of Dr. Pongsaton Phapugrangkul, Director of Biodiversity Research Centre (BRC), Prof. Dr. Amorn Chaiyasat, Prof.Dr. Preeyaporn Chaiyasat, and Ms. Jittaya Sadchaiyaphum, from Faculty of Science and Technology, Rajamangala University of Technology Thanyaburi. The first award received was the Gold Medal Award and Special Prize on Stage from Seoul International Invention Fair 2019 which was held during 27-30 November 2019 at Seoul, South Korea. The second award was the Silver Medal Award from Thailand Research Expo 2019 and also won the very good level award from the 8th RMUTT Young Talent Inventor Awards 2019.

Sakaerat Environmental Research Station, TISTR recieved a National Award for the G-GREEN Logo'

Mr. Varawut Silpa-archa, Minister of Natural Resources and Environment, presented the National Award for the G-GREEN Logo to Dr. Chutima Eamchot chawalit, Governor of TISTR. On the occasion of Sakaerat Environmental Research Station has been certified as Green Office at Gold level with a score of 92.43 from Regional Environment Office 11 Nakhon Ratchasima under Green Office project initiated by Department of Environmental Quality Promotion, Ministry of Natural Resources and Environment. The award ceremony was held on 16 December 2019 at Centra by Centara Government Complex Hotel & Convention Centre, Chaeng Watthana Bangkok.

TISTR Governor Receives Outstanding Alumni Award 2019

Dr. Chutima Eamchotchawalit, Governor of TISTR, received the honorary plaque of "the Outstanding Alumni of Faculty of Science Chulalongkorn University Award 2019" on 1 February 2020 at the Faculty of Science, Chulalongkorn University, Bangkok.

Best Paper Award

Dr. Rujira Jitrwung, Research Officer of Expert Centre of Innovative Clean Energy and Environment, together with his team received Best Paper Award from the Thai Institute of Chemical Engineering and Applied Chemistry (TIChe) by presenting the research paper on Bio-methanol synthesis process from syngas derived from crude glycerol cooperating with CO^2.

Best Presentation Award

Mrs. Kamonrat Suksumrit, Assistant Research Officer of Expert Center of Innovative Clean Energy and Environment, won ABB 2020 Best Presentation Award from ASEAN Bioenergy and Bio-economy Conference.

Bronze Award from Thailand Research Expo Award 2020

Professor Sirirurg Songsivilai, M.D., Ph.D., Secretary-General of the National Research Council of Thailand (NRCT), gave Bronze Award to TISTR representative, Ms. Yupin Phummai, Director of Public Relations Division (PRD), Organizational Communication Office (OCO). On this occasion, TISTR presented an exhibition of innovative identity project "Thai Cosmetopoeia Project to Drive Country's Economy". The award ceremony was organized on 6 August 2020 at Centara Grand & Bangkok Convention Centre at Central World, Bangkok.

TISTR received Honorable Mention Award on "Model Organization in Human Rights" 2020

Mr. Somsak Thepsuthin, Minister of Justice, presented an Honorable Mention Award on "Model Organization in Human Rights" 2020 to TISTR in the state enterprise category, received by Dr. Chutima Eamchotchawalit, Governor of TISTR, on 25 September 2020 at Miracle Grand Convention, Bangkok.

TISTR has been Certified of International Standards

• TISTR by Railway Transportation System Testing Centre (RTTC) was certified of testing laboratory accreditation ISO/IEC 17025: 2017, which was considered as the 1st testing laboratory of Thailand that was accredited by Thai Industrial Standard Institute (TISI).

• Expert Centre of Innovative Agriculture (InnoAg), TISTR by Technology Transfer Center of Productivity and Value Added Field Crop (Pineapple), Prachuap Khiri Khan Province was certified of GMP certificate in the scope of the pineapple packaging process in compliance with Agricultural Standard forGood Practice for Fresh Fruit and Vegetable Packing House from the audit of the Central Laboratory (Thailand) Company Limited (CLT).

• Office of Certification Body (OCB), TISTR, received ISO/IEC 17065 accreditation for the scope of Good Agricultural Practice (GAP) on crops, food and organic agriculture, organic plants from the National Bureau of Agricultural Commodity and Food Standards (ACFS).

Flagship Projects

Project on the Analysis and Testing Development of High-Speed Railway System

Railway Transportation System Testing Centre (RTTC), TISTR has brought the application of Science, Research, and Innovation (STI) to support the government's policy on railway transportation. RTTC has also played a crucial role in providing testing and certification services for railway components and products in more than 15 railway construction projects of the Ministry of Transport (MOT) throughout the country; such as Mass Rapid Transit (MRT), Double Track, track rehabilitation, railway route improvement, and many more. RTTC was prompt to be the research and development (R&D) organization in testing andcertification of railway transportation products in order to meet the international safety and standards, covering all types of railways; such as, Double Track, existing and new MRT lines, light rail transit, and high-speed railway, as well as supporting all railway technology from China, Japan, Germany, and Korea. Moreover, RTTC recognized the necessity of the application of modern technology in railway maintenance for continuous and safe services; such as, technology for smart railway maintenance and instant tracking and monitoring of railway and rolling stock in order to ensure maximum safety, mitigate the loss of service opportunities, and minimize maintenance cost. In 2020, RTTC had 10 significant projects in the development of transportation infrastructure; such as Pink Line MRTA Project Khae Rai-Min Buri Section, Red Line MRTA Project Taling Chan-Bang Sue-Rangsit, Dual Track Railway Project from Map Kabao to Jira Junction (1st contract Map Kabao - Khlong Khanan Chit Section), MRTA, track rehabilitation from Chachoengsao Station to Khlong 19 Junction, construction contract on Chachoengsao railroad Thailand-China High-Speed Railway Project from Bangkok to Nakhon Ratchasima, construction of civil works of manhole and underground electrical cables for Pink Line MRTA Project Khae Rai - Min Buri Section, Dual Track Railway Project from Lopburi to Pak Nam Pho (2nd contract Tha Khae - Pak Nam Pho), and construction on Red Line BTS Ticket Vending Machine (TVM). Furthermore, RTTC was ready to render testing and certification services for high-speed railway included testing of mono block concrete sleeper following the BS 13230-2 standard, concrete bearer following the BS 13230-4 standard, fastening system following the BS EN 13146, flash butt welding following the BS EN 14587, and aluminothermic welding following the BS EN 14730.

Project on the Development of Biodegradable Product Testing according to the International Standards

TISTR has continuously developed several research results from the opening of Biodegradable Testing Centre (BioD) in order to increase the national competitiveness in material biodegradation testing and analysis. The research results could also be used as the confirmed information on the quality of environmentally-friendly products. The Material Biodegradation Testing Laboratory (MBT) under the Material Properties Analysis and Development Centre (MPAD), or so-called BioD, has received the recognition from the international accreditation body organizations; such as, DIN CERTCO, Biodegradable Products Institute (BPI), and Thai Industrial Standards Institute (TISI). BioD was ready to provide biodegradation testing services following the certification ISO/IEC 17025 covering all products that would have the environmental impact according to the regulations of the partner countries. Moreover, BioD helped fulfill the needs of entrepreneurs in industrial and agricultural industries and domestic and international service sectors,who wanted to present the environmental responsibility and attempted to enhance the biodegradable product quality in order to obtain the certified mark and logo that were neutral, indicated information for consumers, as well as supported the research projects of the public and private sectors. Besides, BioD as a linkage for maximizing the research results at laboratory scale to product trial and manufacturing at the industrial level for commercialization following the OECD 301 (Ready Biodegradability). In addition, BioD has operated biodegradation testing and analysis following the ISO 17088 for 26 entrepreneurs, preliminary biodegradation test in compost fertilizer and seawater, and chemical composition analysis, which generated 4.82 million baht in revenue. Apart from that, BioD provided training in the specifications for compostable plastics following the ISO 17088 and product certification.

Research and Development Project on the Standards of Innovative Herbal Extracts with Economic Potential to Upgrade and Drive the Herbal Product Industry

The Expert Centre of Innovative Herbal Products (InnoHerb), TISTR conducted research and development (R&D) on herbal extract production technology to obtain the quality in accordance with international standards, while upgrading the laboratory to achieve the standard certification of ISO 17025 (Quality Control Methods of Gallic Acid, Ellagic Acid, and Cordyceps). InnoHerb strived for the laboratory standard upgrade in alternative safety testing of herbal extracts and cosmetic products following the OECD-GLP in order to receive the product certification and export to Europe and America. Besides, InnoHerb was applying for the ISO 17025: 2017 standard certification in Escherichia coli contamination testing in herbal medicinal products. InnoHerb carried out the study of pharmacological and toxicological activities for information supported as comprehensive research studies and standards on the effectiveness and safety of Thai herbal extracts. Moreover, InnoHerb improved the stability and efficacy of Thai herbal extracts with the delivery and encapsulation innovation. InnoHerb encouraged entrepreneurs to use high quality herbal extracts supported with scientific information in order to enhance the standards of Thai health products. Additionally, InnoHerb created a cooperative network among research institutes, universities, private companies, manufacturers, importers, and exporters related to herbal extracts. InnoHerb conducted the analysis of essential oils and joined hand with Thai Industrial Standards Institute (TISI) to establish 7 standards, which were Phlai Essential Oil Thai Industrial Standard – TIS 1679, Clove Essential Oil TIS 1680, Lemongrass Essential Oil TIS 1681, Citronella Essential Oil TIS 1682, Kaffir Lime Peel Essential Oil TIS 2078, Kaffir Lime Leaf Essential Oil TIS 2079, and Sweet Basil Essential Oil TIS 2080.

Project on Environmental Problem Solving and Plastic Waste in the Community for Sustainable Integration

TISTR in integration with provincial administrative organization and subdistrict administrative organization utilized the knowledge on science, technology, and innovation (STI) and developed the innovation to solve municipal waste following the Circular Economy. The project focused on waste management, value addition from recycled waste, efficiency of renewable energy, and local product innovation to pursue the Sustainable Development Goals (SDGs).These projects were, for instance, the value addition of plastic waste and municipal waste management for income generation in Tan Diao sub-district administrative organization, Kaeng Khoi district, Saraburi province. The center of sustainable management of municipal waste utilizing STI and waste management technology was established, comprised 3 parts: 1) a semi-automatic waste sorting system, consisted of a waste sorting machine to handle old and new waste with the production capacity of 20-40 tons per prototype/NIR sorter for sorting types and colours of waste/biogas production for water treatment, and organic fertilizer and soil conditioner production; 2) plastic segregation by types and colours with NIR and Vision systems, which could separate PVC from other types of plastic and produce clean, quality recycled plastic granules with the production capacity of 100 kilograms per hour; 3) technology and innovation of biofuel and soil conditioner production, consisted of a compressed bio-methane gas production system, soil conditioner production system, and refuse derived fuel (RDF) production system. The project implementation resulted in an increase of plastic granules production volume more than 1 ton per week, increase in employment of no less than 10 new hires, income earnings from recycled plastic product sales no less than 15,000 baht per month, from high quality refuse derived fuel (HQRDF) sales no less than 10,000 baht per month, and from value added recycled waste; such as, charcoal deodorizer and ant and insecticide chalk about 5,000 baht per production cycle, promotion of HQRDF usage, exchanges of knowledge and opinions, integration of activities among public agencies, private organizations, and communities, and better quality of life for local people. The center of sustainable management of municipal waste carried out the technology transfer and provided training on plastic waste segregation in order to completely add value to plastic waste at the sub-district administrative organization in the environmental area. In addition, this centre helped manage municipal waste and wastewater through value-added, recycled products and bio-renewable energy, training, workshop, technology transfer, and readiness preparation of human development in waste recycling production processes.

Project on Shared Product Service Center

TISTR executed the project on Shared Product Service Centre or so-called Community Kitchen "Knowledge and Facility Sharing for everyone's benefits".The Community Kitchen was a learning centre located in the local community (area-based) with the aim to foster the application of local wisdom of the villagers, blend with the knowledge of science, technology, and innovation (STI), as well as to encourage the sharing of equipment and machinery for the standard production processes in order to create local identity products under the concept of helping each other in the community. Moreover, there was a network of collaboration in quadruple helix among public sector, private sector, academic institutes, and communities working together to expand and grab good opportunities for villagers, create stable, sustainable jobs and incomes, and reduce social inequality. Presently, there was 3 Shared Product Service Centres that have been certified by the Food and Drug Administration (FDA) for the upgrade of local identity products as follows : 1) Community Kitchen of mangosteen processed products in Song Khla province– upgrading the standards and production processes of ready-to-drink mangosteen juice and passion fruit juice, preserved mangosteen and mulberry products, and banana processed products under the brand Rhino Hill; 2) Community Enterprise of small fishery group in Rayong province – upgrading the standards and production processes of fried fish bone and sea mussels; and 3) Community Kitchen for mushroom processed products and community enterprise of organic agriculture in Nan province – upgrading the standards and production processes of crispy oyster mushroom and curry pastes.

TISTR has continuously worked in other areas of Thailand to foster the happiness, stability, prosperity, and sustainability of the communities.

Completed Research and Development Projects in 2020

Thailand Institute of Scientific and Technological Research (TISTR) conducts research and development based on mission of integration approach under 3 dimensions of economic development which are Bioeconomy – to focus on maximizing the use of resources, Circular economy - to consider the reuse and recycling of materials maximally and Green economy - to focus on solving pollution problems. In fiscal year 2020 there were a total of 45 research and development projects completed under the operations of Expert Centres of Innovation (ECI), Biodiversity Research Centre (BRC), Thai Packaging Centre (TPC) and Digital and Information Office (DIO) as follows:

1) Expert Centre of Innovative Agriculture (InnoAg)

InnoAg aims for excellence in agricultural technologies for community, integrated research and development based on the country's specific needs, practical for both social and commercial uses, and developing essential infrastructure for supporting the country's social and commercial development. InnoAg has expertise in organic agriculture, research and promoting growing of herbs, local and new economic plants, development and cultivation of mushroom, fertilizer technology, biocontrol, microorganisms and bioproduct for agriculture, post harvest technology, plant breeding and tissue culture, and plant genetic conservation.

In fiscal year 2020 there were 6 projects completed as follows:

1.1) Research and development on production of mushroom spawn and instant organic supplement for organic Japanese mushroom production

1.2) Development of biocontrol agent for microorganisms contaminated in organic Japanese mushroom production system

1.3) Research and development of shelf-life extension technology for Japanese mushroom and eco-friendly packaging

1.4) Research and development of health product for anti-aging from Japanese mushroom extract in semi-pilot scale

1.5) Research and development of structural modification of coconut oil for active ingredient in anti-inflammatory massage oil product using biocatalyst technology

1.6) Research and development of Gros Michel (Hom Thong) banana seedling production system for reducing genetic variation from tissue culture

2) Expert Centre of Innovative Health Food (InnoFood)

InnoFood focuses on research and development for adding value to domestic raw materials and health food products as well as providing infrastructural service to support entrepreneurs in research and development to commercialization. InnoFood has expertise in functional food and beverage products, dietary supplement, natural ingredients in food and machinery or equipment design for food production.

In fiscal year 2020 there were 4 projects completed as follows:

2.1) Development of health food and beverage from bastard Oleaster (*Elaeagnus latifolia*)

2.2) Research and development of dietary supplement containing polyunsaturated fatty acids from byproducts of local fishing industry

2.3) Development of SMEs scale riceberry film forming machine

2.4) Partnership program in production of graduates in Master's degree and Doctoral degree between TISTR and educational institutions (Phase 3)

3) Expert Centre of Innovative Herbal Products (InnoHerb)

InnoHerb focuses on expertise in cosmeceutical and pharmaceutical products from herbs, acting as an integration center of research, development, services and innovation in herbal health products with recognition at international level. InnoHerb has expertise in herbal extraction technology and study of pharmacological and toxicological activities.

In fiscal year 2020 there were 13 projects completed as follows:

3.1) Research and development on extraction process of bioactive compounds in glycosaminoglycan and collagen groups for using in cosmetic and dietary supplement industry

3.2) Research and development of dietary supplement from gelatin and polysaccharides extracted from local fishing industry for supporting gut immune system for the elderly

3.3) Research and development of dietary supplement in reducing inflammatory and enhancing joint strength for the elderly

3.4) Research and development of calcium dietary supplement from local fishing industry for bone strength of the elderly

3.5) Formula development and stability evaluation of nanoparticles cosmeceutical products from active compound groups of beta-glucan, coenzyme Q10, polymeric proanthro-cyanidine and alpha tocopherol for skin brightening and youth restoring

3.6) Clinical testing in volunteers for evaluation of skin brightening and youth efficacy and safety of nanoparticles cosmeceutical products from active compounds in plants and micro-organisms

3.7) Research and development of innovative encapsulation and control release of coconut oil for active ingredient in skin hydrating product by using nanocapsule technology

3.8) Research and development of innovative encapsulation and delivery of asta-xanthin for active ingredient in skin brightening product by using nanocarrier technology

3.9) Research and development on herbal extract delivery system for enhancing cellulite reduction efficacy of body firming product by using lipid nanoparticles technology

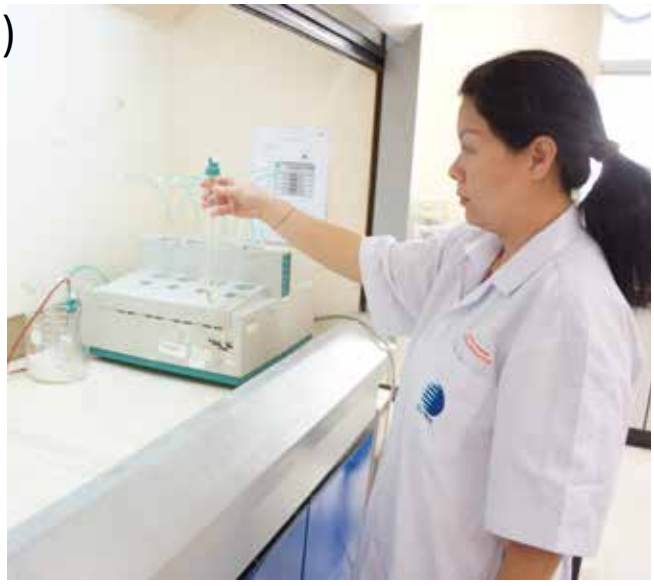
3.10) Research and development on 3D reconstructed human epidermis from cultured tissues for safety and effectiveness evaluation of cosmetic products at preclinical level by using biomolecular technology

3.11) Research and development of cosmeceuticals from bastard Oleaster fruit (*Elaeagnus latifolia*)

3.12) Capacity development in science and technology concerning national animal research

3.13) Study and efficacy evaluation in clinical testing of innovative cosmetic products

4) Expert Centre of Innovative Clean Energy and Environment (InnoEn)



InnoEn focuses on excellence in renewable energy, environmental management for integration into sustainable green economy and society of the country, and infrastructure development for transferring of knowledge, technology and innovation. InnoEn has expertise in clean energy from biomass, management of environment and energy resources in projects, climate change, regulations/mechanisms of carbon footprint and water footprint.

In the fiscal year 2020 there were 6 projects completed as follows:

4.1) Solution for environment and community plastic waste for sustainable integration (Saraburi province area)

4.2) Environmental management model for organic Japanese mushroom house

4.3) Research on potential assessment of production technology of methanol from glycerol

4.4) Research on synthesis and development of catalysts from agricultural materials for potential value in production of methanol from glycerol

4.5) Research on semi-pilot scale production of methanol from glycerol for recycling as an initiator in a biodiesel production process

4.6) Preparation of model and biological water quality index for sustainable water management: Huai Luang dam reservoir case study

5) Expert Centre of Innovative Materials (InnoMat)

InnoMat focuses on research and development of innovative materials, transfer of technology and innovation for supporting and promoting industrial sector development, and creation of sustainable area-based jobs and income. InnoMat has expertise in research development on technology and innovation of health materials, energy and environmental materials, as well as natural materials for adding value and standard of products.

In fiscal year 2020 there were 6 projects completed as follows:

5.1) Development of constructed wetlands system combined with photocatalysis process

5.2) Research on synthesis of cellulose acetate biopolymer from aquatic weeds

5.3) Research on development process of fiber from aquatic weeds for application in composite materials

5.4) Research and development of membrane technology for peptide hydrolysate production process

5.5) Development of innovative materials for health care

5.6) Study and development of appropriate membrane technology for bio-energy reactor tank

6) Biodiversity Research Centre (BRC)

BRC is a center for collection, conservation and conduct of research and development on sustainable usages of the country's biological resources, to increase the country's competitiveness in bio-industry and bio-economy at both regional and global levels. BRC has expertise in collection, preservation and management of biological database, namely, microorganisms, plants and animals and research development in technology and innovative bio-substances and bio-products.

In fiscal year 2020 there were 3 projects completed as follows:

6.1) Research and development on innovative production of xanthophylls from microalgae for an active ingredient in sun protection products by using genetic engineering technology

6.2) A model center in integrated biodiversity management

6.3) Biotechnology transfer for model farm development according to the Royal initiative in Pattani province

7) Thai Packaging Centre (TPC)

TPC is a national packaging technology centre to uplift packaging standards to meet national and international standards in order to maintain the quality of products, reduce the loss of products caused by non-standard packaging and develop packaging to increase efficiency in export. TPC has expertise in packaging development and testing.

In fiscal year 2020 there were 5 projects completed as follows:

7.1) Convenient packaging for improving health quality of the elderly

7.2) Biodegradable antimicrobial films for food packaging

7.3) Smart lables for indicating the freshness of seafood

7.4) Competency development in food packaging testing service

7.5) Establishment of a centre of innovative packaging design for small and medium enterprises (SMEs)

8) Digital and Information Office (DIO)

DIO is a unit to support the development of information technology systems, provide information services with modern, up-to-date information, and also design of digital system for the support of organizational development.

In fiscal year 2020 there was 1 project completed as follows:

- Research development of a mobile application for providing health information on functional food packaging

9) Technology and Innovation Management Office (TIO)

TIO is a unit to drive technology transfer for the benefits of both commercial and social usages. The mechanisms for innovative business development are also provided, including feasibility and marketing opportunity of commercial research.

In fiscal year 2020 there was 1 project completed as follows:

- STI market development for technology transfer to SMEs

which covered these following projects:

- Operating budget of STIM and technology management
- Technology readiness assessment for commercial usage (Thailand Technology Commercialization Assessment – TTCA)
- Development of Electronic, Science, Technology and Innovation (ESTI) market system, information management and digital technology development to support customer services

Patents and Petty Patents

In fiscal year 2020 TISTR filed 63 projects as registered with Department of Intellectual Property, accounting for 22 patents and 41 petty patents as follows:

No.	Patents
1.	Multi-step process for producing methanol from crude glycerol with carbon dioxide
2.	Package with handle for fresh produce
3.	Process of infection treatment with Walk-thru Cleaner Box (WTC Box)
4.	Walk-thru Cleaner Box (WTC Box)
5.	Formula and process for producing visible wavelength titanium dioxide photocatalyst for water treatment.
6.	RDF-5 screw compression fuel feed pelletizing machine that can control the feed rate of fuel material
7.	Plastic and aluminum foil separation process from the UHT package using organic acid solvents
8.	The methanol production process from carbon dioxide combined with hydrogen gas through the Reverse Water-Gas Shift (RWGS) process on copper zinc oxide alumina catalyst (Cu/ZnO/ Al_2O_3) in a multi-temperature high-pressure reactor
9.	Box
10.	Collecting machine of PM 2.5 in the air on the filter paper roll using an incident filter system
11.	Multi-temperature high-pressure reactor for the production of methanol from carbon dioxide and hydrogen gas
12.	Jar opener Type 1
13.	Box
14.	Box
15.	Whale shaped bottle opener
16.	Threaded bottle cap
17.	Biofilm production process from aquatic weed

18.	Odor-Proof Box
19.	Collecting machine of PM 2.5 in the air on the filter paper roll using an incident filter system
20.	High-intensity exposure-downward spiral tubular algae culture system, downflow, phenotype, photo-bioreactor
21.	Algae production system using air bubble aeration
22.	Algae production system from high concentration carbon dioxide in algae spray system

41 Petty Patents filed in fiscal year 2020

No.	Petty Patents
1.	Production process for polishing products from fruit-peel charcoal
2.	Formula and process for the manufacture of high-elastic footprint bags made from natural rubber
3.	Bastard Oleaster energy drink recipes and manufacturing process
4.	Formula and production process of composite floodgate from thermosetting plastic
5.	Recipe and method of culturing *Chaetophora* sp. algae to obtain high polysaccharide content
6.	Compound natural rubber formulation for the process of coating on patient support belt products
7.	Process for producing container from leaves and plant pulp
8.	An inoculator for mushroom spawn
9.	Production process of Refuse-Derived Fuel-5 (RDF-5) from plant fibers
10.	Mushroom spawn forming equipment
11.	Household Biomass stove
12.	Recipe and production process for soft gummy jelly from Bastard Oleaster
13.	Peeler and slicer for ready to eat pineapple
14.	Semi-automatic washing machine for sapodilla
15.	Portable sedge leaf splitting device
16.	Capsule filling aid device for herbal medicine
17.	Dough film forming machine
18.	Distilled spirits products made from Japanese rice and Japanese yam

19.	Product design and production process of micro-emulsion serum from Bastard Oleaster extract for nourishing and whitening skin
20.	Product design, formula and production process of nanostructured lipid carrier containing caffeine and coconut oil mixture for use in cosmetic products
21.	Product design, formula and production process for producing yogurt-like products from eggs
22.	Product design, formula and production process for protein drink from albumen
23.	The sun-dried banana pressing machine driven by a continuous double horizontal feed system controlled by a liquid through orifice plate
24.	Anti-aging cosmetic product in gel form mixed with coenzyme Q10
25.	Formula and production process of biochemical fertilizer with selenium for white jasmine rice 105
26.	Skincare cosmetic product in gel form mixed with beta-glucan nano-emulsion from yeast (*Saccharomyce cerevisiae*)
27.	Production process of coagulant from oyster shell
28.	Formula and production process for ready-to-drink products from herbs - concentrated mushroom soup to reduce fat cells
29.	Membrane performance test kit
30.	Formulas and production processes for ready-to-eat powder from *Garcinia cambogia* extract mixed with probiotic microorganisms
31.	Semi-automatic threaded rod durian cutting machine
32.	Water saving plant pots
33.	Polysulfone nano-titanium dioxide, ultrafiltration hollow fiber membrane
34.	Semi-automatic flesh separator mangosteen peeler
35.	Formula and production process of modified coconut oil acne gel
36.	Carboxymethylcellulose production process from bagasse
37.	Formula and production process of facial serum products with astaxanthin micro emulsion for skin brightening
38.	A 3-D skin cell regeneration process to apply for assessing the skin irritation potential of chemicals
39.	Facial and sun care products containing xanthophylls from seaweed (*Celastrummorus*)
40.	Methods for the retention of xanthophylls from seaweed (*Celastrummorus*) active for anti-wrinkle and skin pigment reduction with lipid carrier technology
41.	High-value xanthophyll production process from *Celastrummorus*

National and International Publications

There were a total of 77 publications (as of 30 September 2020) as follows:

National and International Publications

No	Title	Journal/Proceedings
1.	Total phenolic and gallic acid contents in fresh and preserved *Emblica officinalis* Gaertn fruits from five different varieties	Srinakharinwirot University (Journal of Science and Technology) , 2019, 11 (22), pp.13-22
2.	Reduction of greenhouse gas emissions from different fertilizer uses with zeolite 4A	Srinakharinwirot University (Journal of Science and Technology), 2019, 11 (22), pp.131-145
3.	Physical properties of cement fiber from Napier grass Vol.7 Issue 2 (2019)	Udon Thani Rajabhat University Journal of Science and Technology, 2019, 7 (2), pp. 129-146
4.	Single application fertilizer for melon (*Curcumis melo* L.) production)	Thai Journal of Science and Technology, 2020, 9 (2), pp. 211-217
5.	Effect of Gamma Irradiation on Morphological of Character *Curcuma* Hybrid	Thai Journal of Science and Technology, 2020, 9 (2), pp. 243-250
6.	Breaking dormancy of Morning Glory seeds by dielectric barrier discharge cold plasma	Thai Journal of Science and Technology, 2020, 9 (2), pp 325-332
7.	Packaging status and using problem for elderly people in Thailand	Agricultural Sci. J., 2019, 50(2) (Suppl.), pp. 161-164

8.	Efficient use of fly ash as a mineral for biogas production from co-fermentation of cow manure and Napier grass Pak Chong 1	ARUCON 2019 (12 – 13 December 2019) at Phranakhon Si Ayutthaya Rajabhat University, Phra Nakhon Si Ayutthaya Province, pp. 601-606
9.	An assessment of carbon dioxide emissions from surface respiration in primary dipterocarp forest ecosystems, Nakhon Ratchasima Province and secondary dipterocarp forest, Ratchaburi Province	The 13th Srinakharinwirot University Research Conference 2020 (25-26 March 2010) at Prof. Saroj Buasri Innovation Building, Srinakharinwirot University, pp.1-11
10.	Chemical composition of passion fruits and processing of dehydrated passion fruits	The 5th Valaya Alongkorn Rajabhat University National Conference 2020 (1 May 2020) at Petchaburi Witthay-alongkorn F 5, Science Complex Building, Valaya Alongkorn Rajabha-tUniversity under the Royal Patron-age, Pathum Thani Province
11.	Inspection of sulfate particles and heavy metals contami-nated in dust at Sakaerat Biosphere Reserve Forest, Nakhon Ratchasima	The 19th National Environmental Conference (27-29 May 2020) The Heritage Chiang Rai, Chiang Rai Province, pp. 1-7
12.	Stress Analysis of a 48 kg LPG Cylinder Tank	Proceedings of 15th Siam Physics Con-gress (June 4-5, 2020) Online through hubs
13.	In vitro antioxidant effect of Prunus salicina extract associat-ed with its protective effect against H_2O_2-induced skin cell toxicity	The 50th National Graduate Research Conference (6-7 June 2020) King Mongkut's Institute of Technology Ladkrabang, pp 47-55

International publications - 64 articles

No	Title	Journal/Proceedings
1.	Performance verification of the photocatalytic solar water purification system for sterilization using actual drinking water in Thailand.	Journal of Water Process Engineering, 2019, V. 31, pp. 1-8
2.	Effectiveness of bastard oleaster (*Elaeagnus latifolia*) extracts against the nymph of mealybug (*Phenacoccus manihoti*)	*Acta Horticulturae*, 2019, V. 1, pp. 127-134
3.	Insecticidal properties of bastard oleaster (*Elaeagnus latifolia*) extracts against diamondback moth (*Plutella xylostella*)	*Acta Horticulturae*, 2019, V. 1, pp. 135-142
4.	Tadpoles of Khao Wang frog Humerana miopus (Amphibia, Ranidae): Description of external morphology and buccal anatomy	Maejo International Journal of Science and Technology, 2019, V. 13 (03), pp. 217-230
5.	New records of praying mantis (Mantodea) from Thailand	Far Eastern Entomologist, 2019, Number: 395, pp. 23-32
6.	Are the habitat niches of female green pit vipers Cryptelytrops macrops and Viridovipera vogeli partitioned by vertical stratification?	The Herpetological Bulletin, Issue Number 149-Autumn 2019
7.	Protective effect of valproic acid on MPP+-induced neurotoxicity in dopaminergic SH-SY5Y cells through Cdk5/p35/Erk signaling cascade	Tropical Journal of Pharmaceutical Research, November 2019, V. 18 (11), pp. 2255-2261
8.	GC-MS analysis and biopesticide properties of different crude extracts of *Annona squamosa* and *Annono muricata*	International Journal of Agricultural Technology, November 2019, V. 15 (6), pp. 859-868
9.	Effects of astaxanthin from shrimp shell on oxidative stress and behavior in animal model of Alzheimer's disease	Marine drugs, November 2019, V. 17, Iss. 11, pp. 1-15
10.	Characterization of prebiotics and their synergistic activities with Lactobacillus probiotics for β-glucuronidase reduction	ScienceAsia, December 2019, V. 45 (6), pp. 538-546

11.	Metformin Inhibit cervical cancer migration by suppression the FAK/Akt Signaling Pathway	Asian Pacific Journal of Cancer Prevention, December 2019, V. 20 (12), pp. 3539-3545
12.	Effects of oxygen micro/nano bubbles on germination of sunflower seeds (*Helianthus annuus*)	International Journal of Plasma Environmental Science and Technology, December 2019, V. 13, No. 2, p.54-58
13.	Isolation and characterization of *Enterococcus faecium* DSM 20477 with ability to secrete antimicrobial substance for the inhibition of oral pathogen *Streptococcus mutans* UKMCC 1019	Archives of Oral Biology, 2020, V. 110, pp. 1-9
14.	Surface modification of tapioca starch by using the chemical and enzymatic method	Starch, March 2020, V. 72 (3-4), pp. 1-6
15.	Habitat structure affects nest predation of the Scaly-crowned Babbler (*Malacopteron cinereum*) by macaques and snakes in a Thai-seasonal evergreen forest	Journal of Ornithology, April 2020, V. 161 (2), pp. 389–398
16.	An application of a cumulative-sum control chart for elderly fall detection using smartphone accelerometers	Science & Technology Asia, April - June 2020, Vol. 25 No. 2, pp. 36-46
17.	Self-assembled polydopamine nanoparticles improve treatment in Parkinson's disease model mice and suppress dopamine-induced dyskinesia	*Acta Biomaterialia*, June 2020, V. 109, pp. 220-228
18.	Superficial Pd nanoparticles supported on carbonaceous SBA-15 as efficient hydrotreating catalyst for upgrading biodiesel fuel	Applied Catalysis A: General, July 25, 2020, V. 602 (117707), pp. 1-13
19.	Development of qualitative and quantitative immunochromatographic strip test assay for rapid and simple detection of leucomalachite green residual in aquatic animals	Food Chemistry, 1 August 2020, V. 320, Article 126613, pp. 1-8
20.	No room to roam: King Cobras reduce movement in agriculture	Movement Ecology, Published 03 August 2020 8, Article number: 33 (2020) DOI https://doi.org/10.1186/s40462-020-00219-5

21.	Purified gymnemic acids from *gymnema inodorum* tea inhibit 3t3-l1 cell differentiation into adipocytes	Nutrients, September 17, 2020, 12(9), 2851; https://doi.org/10.3390/nu12092851
22.	Screening of potential probiotic *Bacillus* for aquaculture industry	Proceedings of the 31st Annual Meeting of the Thai Society for Biotechnology and International Conference (TSB2019), November 10-12, 2019, Phuket, Thailand, pp. 216-224
23.	Effects of the flavonoid luteolin on oxidative stress in Parkinson's disease model	Proceeding of the 31st Annual Meeting of the Thai Society for Biotechnology and International Conference (TSB2019), November 10-12, 2019, Phuket, Thailand, pp. 470-481
24.	Characterzation of fusing CBM6 within *Penicillium oxalicum* endo-1,4-beta-xylanase GH11 and its effectiveness on insoluble degradation	Proceeding of the 31st Annual Meeting of the Thai Society for Biotechnology and International Conference (TSB2019), November 10-12, 2019, Phuket, Thailand, pp. 620-635
25.	Molecular and morphological identification of banana thrips in Chantaburi province, Thailand	Proceedings of the 8th International Conference on Integration of Science and Technology for Sustainable Development (8th ICIST), November 19 - 22, 2019 at Huiyuan International Hotel, Jingde, Anhui province, PR China
26.	Effect of equivalent ratio variation on a two-stage distributed combustion	Proceedings of the 10th TSME International Conference on Mechanical Engineering, December 10–13, 2019, Pattaya, Thailand
27.	Antibacterial activity of fatty acids from enzymatically hydrolyzed virgin coconut oil using different types of lipase	Proceedings of the International Conference on Food and Applied Bioscience 2020 : Insights for Research and Industry 4.0, February 6-7, 2020, Chiangmai Grandview Hotel & Convention Center Chiang Mai, pp. 288-294

28.	Evaluation of environmental impacts for municipal waste management in Tandeaw sub-district, Saraburi province	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Nonthaburi, Thailand, pp. EC6-EC11
29.	Amino acids profiling, cytotoxicity test and nitric oxide inhibition of gelatin extracted from jelly fish (*Lobonema smithii*) derived from local fishery	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Nonthaburi, Thailand, pp. FA20-FA24
30.	Reactivity of lithium carbonate and rice husk ash derived lithium orthosilicate by solid state reaction	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Nonthaburi, Thailand, pp. IC6-IC11
31.	Enhancing the fouling resistance of ultrafiltration polysulfone hollow fiber membranes with nanoparticles TiO_2-P25	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Nonthaburi, Thailand, pp. MN14-MN19
32.	Effect of the amine treatment on the hydrophilicity and antifouling properties of flat sheet poly(vinylidene fluoride) membranes	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Nonthaburi, Thailand, pp. MN74-MN79
33.	Fabrication of ceramic membrane bioreactor for agricultural wastewater treatment	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Bangkok, Thailand, pp. MN180-MN183

34.	Isolation of cellulose from natural aquatic weeds: water hyacinth and cattail	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Nonthaburi, Thailand, pp. PC64-PC69
35.	Synthesis and characterization of cellulose acetate from tropical cattail using homogeneous catalyst	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Nonthaburi, Thailand, pp. PC70-PC76
36.	Homogeneous acetylation of cellulose with acetyl chloride to cellulose acetate from water hyacinth	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Nonthaburi, Thailand, pp. PC90-PC95
37.	The possibility of improvement techniques for oxidation stability of tung biodiesel	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Bangkok, Thailand, pp. RE66-RE71
38.	The effect of monoglyceride content on the precipitate formation of palm biodiesel-petroleumdiesel blended with various storage temperature	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Bangkok, Thailand, pp. RE72-RE75
39.	High quality bio-coal derived from durian wastes via hydrothermal carbonization	Proceedings of the Pure and Applied Chemistry International Conference 2020 (PACCON2020), February 13-14, 2020, IMPACT Forum, Muangthong Thani, Bangkok, Thailand, pp. RE76-RE80

40.	Effect of sodium acetate and sodium chloride on production of lutein, zeaxanthin and canthaxanthin In chlorella zofingiensis	Proceedings of the International Conference and Exhibition on Pharmaceutical Sciences and Technology 2020 (PST2020), May 19-20, 2020, College of Pharmacy, Rangsit University, Thailand, pp. 73
41.	Partitioning of soil respiration in primary dry dipterocarp forest at Nakhon Ratchasima Province, Thailand	Proceedings of the 9th International Conference on Environmental Engineering, Science and Management, October 7-9, 2020 The Heritage Chiang Rai, Thailand
42.	Bio-methanol synthesis process from syngas derived from crude glycerol cooperating with CO_2	Proceedings of the 29th Thai Institute of Chemical Engineering and Applied Chemistry Conference (TIChE2020), June 1-2, 2020, The Tawana, Bangkok, Thailand, pp. 197-203
43.	Effect of gelation addition on physio-chemical characteristics of Bastard oleaster gummy jelly	Proceedings of 7th International Conference on Food Agriculture Biotechnology 2020 (ICoFAB 2020), July 29-30, 2020, Faculty of Technology, Mahasarakham University (MSU), DOI Number : 10.14457/MSU. res.2020.3
44.	Investigation the physical, mechanical properties Of edible film from riceberry flour	Proceedings of 7th International Conference on Food Agriculture Biotechnology 2020 (ICoFAB 2020), July 29-30, 2020, Faculty of Technology, Mahasarakham University (MSU), DOI Number : 10.14457/MSU. res.2020.9
45.	Anti-inflammation, anti-obesity and cytotoxicity evaluation of the active constituents from the *Boesenbergia pandurata* and *Kaempferia parviflora* extract mixtures	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 76-78

46.	Inhibition of nitric oxide production in RAW264.7 macrophage cells by stingless bee honey	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 99-100
47.	Antioxidant activities by dpph, Abts, Frap Assays, Anti-tyrosinase and total phenolic content evaluation of the three flower extracts and their serums	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 105-106
48.	Sacha inchi promoted the performance of muscle strength in mice	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 107-109
49.	Phenolic profile and antioxidant activity in three varieties of melon (*Cucumis melo* L.)	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 117-118
50.	Probiotic property and health benefit of *bifidobacterium animalis* Subsp. *lactis* TISTR 2591 isolated from Thai population	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 122-123
51.	Anti-oxidant, anti-malanogenesis and anti-DNA damage activities of Thai Probiotic: *Bifidobacterium animalis* Subsp. *lactis* TISTR 2591	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 124-126

52.	Preliminary study on antioxidant activity of mulberry fruits extraction	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 129-130
53.	Determination of antioxidant activity in green microalgal (*chlorella zofingiensis* and *Coelastrum* sp. TISTR9501RE)	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10 - 12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 131-132
54.	Anti-Inflammatory Effect of *Auricularia auricula-judae* in LPS-Stimulated RAW 264.7	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 133-134
55.	Inhibitory effects of (black) wood ear mushroom extract on melanin production	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 139-140
56.	Anti-tyrosinase activities of Miang (*Camellia sinensis* var. *assamica)* extracts	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 145-146
57.	Inhibitory effects on lipid accumulation and cytotoxic of selected thai herbal extract	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 149-150

58.	Antifungal activity against *Candida albicans* and antiinflammatory property of *Morinda citrifolia*	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 151-153
59.	Development and validation of three-dimensional skin equivalent for the investigation of skin irritation	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 154-156
60.	Dermal health screening of Probiotics TISTR stains on HaCaT keratinocyte cell line	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 157-158
61.	Anti-oxidant activities and total phenolic content Of five seaweed species in thailand.	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 167-168
62.	Quantitative analysis of alpha hydroxyl acid (AHAs) in Thai native fruits	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 169-170
63.	Preliminary study on the anti-wrinkle effect of coenzyme Q 10 extracted from microorgamisms loaded-microemulsion based eye gel.	Proceedings of the 6th Current Drug Development (CDD) International Conference 2020, September 10-12, 2020, Lee Gardens Plaza Hotel, Hat Yai, Songkhla, Thailand, pp. 188-189
64.	Hydrogen sulfide removal by using zeolite from coal bottom ash in composite adsorbent for odor removal and wastewater treatment	Proceedings of International Conference on Recycling and Waste Management (ICRWM-20), September 13 -14, 2020, Bangkok, Thailand, pp. 44-48

Technology Transfer for Commercial Purposes

TISTR is an innovative organization to meet the needs of the country under the policy of TISTR 4.0 by focusing on researching and developing a variety of science, technology and innovation studies. In this fiscal year 2020, TISTR provided 122 research and consultancy services. Examples of interesting projects are as follows:

Research and Development Group for Bio-industries

Development of anti-aging facial nourishing serum from snail slime in a semi-pilot scale

The product was developed for Aden International Company Limited based on the benefits of snail slime with powerful antioxidant properties. This serum helped restore the skin by repairing damaged skin cells naturally. TISTR conducted research and developed the formula of anti-aging cosmetic products from snail slime of *Achatina fulica.* The objective was to increase income and make use of the snails which are abundantly found in the province of Nakhon Nayok, using them as resource for commercial and export purposes. From the bioactivity test of skin care products from Asha snail slime, it was found to stimulate the production of human skin cells and inhibit the enzyme tynosinase with the outstanding biological skin nourishing effect of snail slime. Therefore, the research was further studied to extensively produce anti-aging facial serum products developed from laboratory scale up to semi-pilot scale and can be commercially available with quality and performance comparable to laboratory research.

Carried out by: Expert Centre of Innovative Herbal Products (InnoHerb).

Licensing of bacteria strains for production of organic compound degradation product in aquaculture growing pond to Thai Union Feedmill Company Limited

Bacillus subtilis (TISTR 010) *Bacillus licheniformis* (TISTR 013) and *Bacillus megaterium* (TISTR 067) bacteria having the degradation activity of organic compounds in aquaculture growing pond were developed into degradation product for utilizing of bacterial degraded organic compounds. TISTR has granted licensing of 3 bacterial strains for production of organic compound degradation product in aquaculture growing pond, under pathogens and animal toxins act B.E. 1982 and second act of B.E. 2001, for use as ingredient in the production and provides academic support and quality control in morphological and biomolecular characteristics

Carried out by : Biodiveristy Research Centre (BRC).

Research and Development Group for Sustainable Development

Technology transfer of natural rubber coating on safety transfer belt to Unity Meditec Company Limited, a manufacturer and distributor of products related to medical supplies and equipment, including health support products, for example, hot pack, hot pack powder and safety transfer belt, etc. Currently, safety transfer belt is highly competitive, product development with new technology integrated with company's product being produced will improve high competitiveness. The company needs to develop safety transfer belt to have specific feature by use of science, technology and innovation to upgrade and increase product effectiveness. This project is technology transfer and training of natural rubber coating on safety transfer belt for appropriate use, extension of patent filing number 1601002323 entitled process of natural rubber coating on fabrics, applied on 22 April 2016.

Carried out by : Expert Centre of Innovative Materials (InnoMat).

Developing a rotated turnable sampling machine to a semi-automatic model to CPF Thailand Public Company Limited. From success of a Gantry Robot sampling machine (X-Y crane), computer based control system, TISTR received reliability and extended results of success. There are 6 projects consisting of

Project	Location
Developing a rotated turnable sampling machine to a semi-automatic model	CPF factory, Lam Phun province
	CPF factory, Phra Nakhon Si Ayutthaya province
	CPF factory, Saraburi province
	CPF factory, Nakhon Ratchasima province
	CPF factory, Chonburi province
	CPF factory, Phitsanulok province

Development of the sampling machine not only allows sampling raw materials conveniently, but also reduces the loss of foreign currency and empower knowledge and ability, as well as expertise to relevant personnel, resulting in sustainable strength of Thai industry.

Carried out by: Expert Centre of Industrial Robotics and Automation (InnoRobot).

Industrial Services Group (ISG)

Standard certification of system instruments to TPI Polene Public Company Limited. Standard quality management system is an important component in trade competition. Requirements of detectors, meters, analytical instruments and testing devices are strictly specified as basic guarantee in product quality, resulting in maintaining the productivity of the country's overall production of goods. TISTR provides services in testing and calibration to industrial sector including analysis in physics, analytical chemistry, biochemistry, micro-biology and calibration of devices and instruments in mass, dimension, force, pressure, volume, density, flow rate, time, electricity, light, sound, temperature and chemicals as well as certificates in testing, analysis and international calibration. Major services received international accreditation TISI 17025-2561 (ISO/IEC 17025: 2017). TPI Polene Public Company Limited is a leading company with good recognition of long-term business, applying an internal standard of ISO 9001 as a key management system with determination to maintain and improve work process system in accordance with international standards.

Carried out by : Industrial Metrology and Testing Service Centre (MTC).

Engineering consultancy service for testing and performance evaluation of bogie container flat wagon to Italian-Thai Development Public Company Limited. The Italian-Thai has been recognized for a long time in manufacturing and assembling of flat wagon. The wagon body must pass testing requirements of State Railway of Thailand (SRT). TISTR is a government agency with readiness in modern analytical instruments and personnel with professional skills and expertise in providing testing services for quality evaluation and product usage life to domestic and international entrepreneurs for a long time in testing of static frame, measurement of bending and camber, vertical lifting test, steering test, braking system test, collision test, weight and weight distribution test for authenticating process of design, production and warranty of safety usage.

Carried out by: Railway Transportation System Testing Centre (RTTC).

Strategies and Innovation Management Group

Master plan development in Research, Development and Innovation of Metropolitan Waterworks Authority, second version (a revised first version) (2020-2023) to Metropolitan Waterworks Authority

Thailand confronts with the context of changes both inside and outside the country in various major dimensions, which affects opportunity and threat to the country's development greatly, including push on the country to reform economic structure to "value-based economy" or "innovation driven economy" to aim for the stable, prosperous and sustainable country by country development process under "Thailand 4.0". The government emphasizes on development and promotion of the use in science, technology and innovation, and approaches to promoting government and private sectors in creating knowledge to agencies and promoting research work in creating innovation within the agencies. Metropolitan Waterworks Authority (MWA) as a state enterprise enables to support the country development based on Thailand 4.0 concept. MWA focuses on development of information and communication technology in all work processes systematically, which help build the organization culture to improve service efficiency, support creation of learning society so that MWA be able to drive the organization according to the vision of becoming a high performance organization to provide water supply service with corporate governance and reach international standard.

Carried out by: Corporate Strategic Planning Office (CSPO).

Feasibility study of Thailand-China Trade Market for Research and Development of Processed Coconut Products by Science, Technology and Innovation to Department of Foreign Trade

The feasibility had objectives to study marketing data and consumer behavior, research and development of processed coconut products for developing entrepreneur capability of Coco Inter Prachin community enterprise group and coconut clusters to have competitiveness in international markets by operation through various types of development projects. The operation consists of knowledge preparation of entrepreneurs and building understanding in upgrading production capability for distribution and export, research and development of processed coconut product model, market testing and Chinese consumer behavior at Guangdong province, Guangzhou city, or other provinces that have economic potential and specify the type of products and packaging, leading to research and development of commercial processed coconut product and packaging models.

Carried out by: Innovation and Business Development Division (IBDD).

Besides, TISTR has a network and integration collaboration with government, state enterprise agencies and private sectors in supporting the use of research and development in science, transferring technology with international standard quality, resulting in empower-ment of small and medium entrepreneurs (SMEs) in Thailand, of which could apply practi-cally, also accelerating action plan and driving for mechanisms, tools, facilities systematically for technology transfer and bringing STI outputs for commercialization. There are 14 projects as follows :

Number	Project	Transferee
1	Technology transfer on production of pain relief product from migraine headache 4GRAINE	Sang Sawang Tra Khang Khao Company Limited
2	Development and technology transfer on liquid dispenser models for body cleansing and container	Organic Links Company Limited
3	Research and technology transfer on model innovation of integrated forest planting for building food resources and developing sustainable community economy	National Research Council of Thailand
4	Research, development and technology transfer on cashew juice production for Had Kai Toy Community Enterprise Group	Electricity Generating Authority of Thailand, Amphoe Tha Pla, Uttaradit province
5	Technology transfer of natural rubber coating on safety transfer belt	Unity Meditec Company Limited
6	Development and transfer training on production of innovative products from brick clay	S.C.C. Intertrade Company Limited
7	Flora cluster development activity under SME support network project, year 2020	Office of Small and Medium Enterprise Promotion
8	Outsourcing knowledge and technology transfer in wild Mycorrhizal mushroom cultivation	Biodiversity-based Economy Development Office (Public Organization)
9	Licensing of bacteria strains for production of organic compound degradation product in aquaculture growing pond	Thai Union Feedmill Company Limited
10	Technology transfer of mushroom spawn dispenser	Sala Loi Economic Mushroom Cultivation Community Enterprise Group
11	Extension development and technology transfer of water reuse and recycling system	Metropolitan Waterworks Authority
12	Development and technology transfer of Budo velvet tamarind shell cracking machine	Princess of Naradhiwas University
13	Development and transfer of effective microorganisms for bio-fermented coconut water	Thai Pure Coconut Company Limited
14	Research development and technology transfer of single-tank fertilizer for use in soilless culture system	S.N.P Scientific Company Limited

Technology Transfer to Social Communities

Thailand Institute of Scientific and Technological Research (TISTR) carried out technology transfer to social communities including farmer groups, community enterprises and public in bringing Science, Technology and Innovation (STI) to enhance the ability in solving area-based and community problems, and create value addition to local produce. There are projects conducted technology transfers, follows:

Development of health product and service capacity with Smart Aging innovation in Southern Economic Corridor (SEC)

TISTR made visits to the areas where the projects were undertaken for adding value to the local production by integrating TISTR's expertise with local wisdom in utilization and processing of agricultural produces, herbal plants and area resources. In this operation, entrepreneurs in the areas have been promoted to access research findings and technologies that can be implemented toward commercialization. The projects aim to add value to biobased economy of Southern Economic Corridor (SEC) and help solve the problem of quantity and low price of seasonal produces. Many meetings were organized between TISTR and representatives of provincial agencies in SEC, namely, Chumphon, Ranong, Surat Thani and Nakhon Si Thammarat provinces. Moreover, the STI event on the use of herbs to increase the tourism and service capacity with related agencies in Southern areas was also held as a workshop on "Development of health product and service capacity with Smart Aging innovation in Southern Economic Corridor (SEC)". In this workshop, knowledge about active ingredients of herbal plants, agricultural produce, extraction was transferred in order to add value to health and beauty products with development by using testing methods and related standards. More than 400 participants of farmer groups, community enterprises and SME entrepreneurs joined in this workshop in order to obtain knowledge in value addition to their produces by using technology and innovation, and improvement of raw materials, nutrients, or active ingredient of economic plants. Problems were collected and consultation services were provided in product development to entrepreneurs in Surat Thani and Chumphon provinces. The knowledge and technology transferred focused on development of technologies on extraction of active ingredients from herbs or local agricultural produces, namely, palm, turmeric, shatavari roots, pineapple, blue trumpet vine, mangosteen, wild piper betel leaves, mineral water, durian and coconut. These local produces could be used as raw maerials in producing cosmetic and herbal products. In this regard, TISTR's technologies were transferred to 19 entrepreneurs, namely, turmeric extract gel, shatavari root extract gel, facial care product from shatavari roots, skin lotion from active ingredient derived from palm, skin care from bromelain extracted from pineapple, facial soap from active ingredients derived from blue trumpet vine and palm, sun protection and facial care products from mangosteen extract, facial serum development from mangosteen and wild piper betel leaves, facial serum from shatavari roots and Sung Yod rice germ, facial care from shatavari roots and piper betel leaves, skin care product from hot spring mineral water mixed with durian extract, body scrub product containing hot spring mineral water, mouthwash product from hot spring mineral water, sun protection cream from coconut oil, scented gel facial care product from extracted fragrance, polysaccharides from durian peel waste obtained from durian orchard, active ingredients from Wan Nang Kham herb, fragrance product from durian blossom from durian orchard in Chumphon province, development of facial and body lotion product from goat milk, and development of coffee blossom tea blended with baby coffee leaves, Krabi province.

Upgrading production of agricultural products from Geographical Indication (GI) plants appropriate to capacity of regional areas

TISTR used knowledge, expertise and service in Science and technology to promote the competitiveness of community enterprise production and processing groups of health and beauty products, in order to add value to local fruits in 5 provinces, namely, Satun, Krabi, Trang, Chumphon and PhangNga, as well as to promote production process, processing and production standard. TISTR transferred technologies for extracting active ingredients from GI and economic local fruits to use in health and beauty products with safety, effectiveness, and quality control. The extract yielded from these local produces were, for example, extract from mangosteen peels using enzyme in the extraction and from Jampada (golden jackfruit). Moreover, health product and cosmetics were developed using active ingredients from GI and economic fruits in the areas, of which 8 products were obtained as follows: 1) ready-to-drink infusion tea from coffee blossom, coffee seeds, a GI plant of Chumphon province 2) cosmetics from Siam red ruby pomelo 3) ready-to-drink infusion tea from coffee blossom, coffee baby leaves (2 groups) a GI plant of Krabi province 4) cosmetics from goat milk, GI produce of Krabi province 5) chilli pastes, Surat Thani province 6) cosmetics from coconut shoots, a GI plant of PhaNgan, Surat Thani province 7) germinated rice soup from Sung Yod rice, Phattalung province 8) cosmetics from Sung Yod rice, GI of Pak Phanang, Nakhon Si Thammarat province. More than 100 participants from community enterprises, farmers and entrepreneurs were transferred of knowledge in science, technology and innovation in making of transparent soap from coconut oil and coffee extract. Also the network was developed among the enterprises in upgrading production capacity and business activity that linked with private and government sectors as well as related agencies to support and promote integrated development, and upgrade production of agricultural the Southern region area for continuous improvement of provincial products to receive more recognition with standard and quality that meet market needs, ready for competition both in domestic and international markets. This would lead to upgrading of agricultural products, particularly GI fruits appropriate to production capacity in the area. With higher value of product improvement, they could have more chance for export and were available for sale in global markets.

Evolution learning centre of plant utilization

TISTR by Lam Takong Research Station is a learning centre for technology transfer in the Northeast region and nearby areas. The important buildings are consisted of Chalermprakiat building (glass house 1 and 2) for organizing living exhibition on biodiversity of plants and insects, as incubation centre for science, technology, innovation in agriculture, conservation and sustainable use of biological resources in the Northeast for students, researchers and general public. Many agricultural technologies were developed for transferring to visitors and customers, for example, organic fertilizer production, plant propagation, planting of Phak Wan Pa, sour tamarind, moon flower, sweet bamboo and local vegetables, non-pesticide vegetable production and organic vegetables, tropical mushroom cultivation, interlocking blocks production and other agricultural managements to enhance production quality for farmers, create jobs, generate income and improve the quality of life. The results showed that more than 6,738 persons visited Chalermprakiat building (glass house 1 and 2), 70 persons involved with camp learning activities on plants and insects, for example, young bio-scientist camp. Besides, other activities were also organized, such as science exhibition on Flora tale and insects, 6 events of painting and photo contest about plants and in-

sects, etc. , namely, 1) flora and botanical garden exhibition 2) exhibition related to botanic research and botanical garden of Lam Takong Research Station 3) Thai resources exhibition : the benefit of Thai people 4) exhibition of plant genetic conservation and utilization of biological resources 5) Open house to technology and 6) online exhibition of flora in honor to Her Royal Highness Princess Maha Chakri Sirindhorn and other plants of honorable names by viewing through Lam Takong Research Station website, as well as Yang Na seedlings distribution activity to temples, educational institutions and communities around the research station for 5 sites, each site of 100 seedlings, for example, to Wat Khao Noi, Amphoe Pak Chong, Pak Chong Industrial and Community Education College, Amphoe Pak Chong, Wat Ban Sap Wai, Amphoe Pak Chong, Ban Sap Wai community forest, Amphoe Pak Chong, and Ban Sap Wai community learning centre, Amphoe Pak Chong, for restoring the forest areas of temples, educational institution and community forest. This could increase green area of neighborhood and also build awareness to surrounding community on the importance of forest planting.

Development of technology and innovation of food products for entrepreneurs

TISTR in collaboration with National Innovation Agency and Bank for Agriculture and Agricultural Cooperatives selected startup entrepreneurs to participate in the project for over 500 persons and organized workshop for making the business readiness and product marketing. TISTR's technology on food product innovation with science and technology was transferred to startup entrepreneurs from product development concept in lab scale to industrial-scale production for market testing, creating the business capabilities and marketing for startup entrepreneurs in achieving food business and promoting access to use of STI infrastructure. Food Innovation Service Plant (FISP), which is infrastructure for providing services to food entrepreneurs in R&D and innovation in food production in industrial scale. Presently, FISP has received permission in production of food products from Food and Drug Administration (FDA). Food products developed and produced from FISP can be available for pre-market sale legitimately. FISP is prompt for carrying out innovative food product to entrepreneurs in high level, helping increase competitiveness, productivity, value addition and decrease marketing constraints, by incubating technology for upscaling from laboratory to industrial scale at an average of technologies/products annually, upgrading food product development to entrepreneurs for more than 150 products, 67 of which were licensed with FDA and readily available for sale such as sugar free syrup, extracts from grape and blueberry for enhancing memory capacity "Memo-phenol", ready to drink collagen "C-Shortz", Ganoderma extract drink, etc.

Development of innovation identity community under collaboration with government agencies and key private sectors

TISTR placed importance on area-based operation, particularly to meet the needs of communities and public in the areas. leading to the innovation identity project for developing innovation identity community under collaboration with government agencies and key private sectors. By bringing knowledge in STI to create identity to product or innovation of community, extending value addition to model products, for example, products developed from herbs, local identity plants to high value added products and returning benefits to local community, such as cosmetics, cosmeceuticals and food products to strengthen community. The operation was compliant with strategic concept of Ministry of Higher Education, Science, Research and Innovation (MHESI) of the third pillar, bringing knowledge, research and innovation for utilization. In fiscal year 2020, the area visits to over 14 communities/collaborations were carried out for developing innovation identity community, from entrepreneurs, community enterprise group, farmers and public in target identity community area and created 14 product prototypes, for instance, Saline Hot Spring Khlong Thom community, Krabi province; skin nourishment products from natural mineral water, Mae Lek tamarind orchard community, Petchabun province; sweet tamarind nectar functional drink, Nature Bright brand, Ban Nam Kian community, Nan province; Litsea leave extracts and extraction equipment for Litsea leaves for hair nourishment products, HomNa Khu Ha community enterprise group, Phrae province; model products for cosmetics from Hom, ThipSaowarot orchard community, Petchabun province; facial nourishment product from avocado extract under the trademark of Mistine, Huai Tat Kha farming community, UdonThani province; mango flavored soya milk and banana flavored soya milk, Tamarind cream group (Mae Sangdee), Phayao province; tamarind facial mask cream, Ganoderma community group, Chiang Mai province; instant red Ganoderma tea pack (orginal flavor), Ban Bang Sadet miniature dolls group community, Ang Thong province; miniature mosaic tiles, Ban KoNoi community, Sukhothai province; SangkhalokSukhothai-painted ceramic perfume bottle, Kud Nam Sai community, Khon Kaen province; crispy puffed rice product from Tubtim rice, Seedling and wild Mycorrhizal mushroom spawn Chum Phae enterprise, Phrae province; Seedlings inoculated with wild Mycorrhizal mushroom spawn product and wild Mycorrhizal mushroom spawn, Nong Pueng community group, Chiang Rai province: refuse derived fuel (RDF) from Sawian (a bam-boo cage for home organic waste) and agricultural residue waste, Khao Sam Muk community group, Chon Buri province: fish tank filter stone product from oyster shells.

Scientific and Technological Services

TISTR by Industrial Services Group (ISG) has provided scientific and technological services in order to enhance the quality of industrial sectors in Thailand and worldwide up to international standard. In fiscal year 2020, TISTR provided scientific and technological services to the total of 2,955 entrepreneurs as follows:

- services on assessment and quality system accreditation 440 items,
- services on analysis, testing, and calibration 205,784 items.
- Training services for private sectors and governmental personnel in total 1,385 persons from 34 training coruses.

TISTR supported the manufacturing industries with scientific and technological services that were accredited under the scope of international standard ISO/IEC 17020, ISO/IEC17021-1, ISO/IEC 17025, ISO/IEC 17065, and ISO/TS 22003 as follows:

Anlysis and testing of materials, products, packaging, and calibration services

TISTR provided analysis and testing of raw materials, products, packaging, and calibration services as follows: railway transportation system testing; testing and calibration of medical equipment and accessories; analysis and testing of food products; research services for environmental bioremediation by bio-based processing including research services/analysis and testing for biodegradation of material and environmentally friendly products; and testing of materials and packaging by standard methods and modern equipment including packaging for retail and wholesale and for transportation. These testing and analysis services were undertaken with standard laboratories that have been accredited according to ISO 9001 and ISO/IEC 17025. There was also a service concerning testing of packaging for hazardous commodities in order to receive UN mark certification for exporting. Moreover, TISTR provided research and development services on packaging including packaging design service, inspection and remaining life assessment (RLA) of boilers in industrial plants, replica test and inspection of furnace in refinery plants, products testing according to Thai industrial standards, sample analysis for registering at Food and Drug Administration (FDA), analysis and testing of paint for building according to TIS 272-2549 and TIS 2321-2549, calibration for industrial measuring instruments such as sound level meter, micrometer, Lux meter. TISTR also provided proficiency testing which was accredited according to ISO/IEC 17043 in the field of temperature and electricity.

In fiscal year 2020, TISTR had high potential to provide new testing, calibration, and accreditation. As a result, ISG had more of customers, leading to higher impact to the income earning as stated in ISG Annual Roadmap in total 16 issues. For example TIS 805-2540 Liquefied Petroleum Gas Pressure Regulator: Low pressure, Benzene testing in fruit juice, impact absorption testing of rubber, resistance testing of bonding force between concrete and rubber before and after deteriorating acceleration, safety performance assessment of rubber fender barrier (RFB) testing by car crashing, Drop test after the sample passed water spray test, Compression test, Flammability test, Moreover, TISTR proposed 13 scopes of testing/analysis for ISO/IEC 17025 such as Pin-on disk wear testing, Solar reflectance test for building paint up to standards.

Quality system accreditation, products and services accreditation according to international standards

TISTR provided assessment and quality system accreditation, products and services accreditation to entrepreneurs both in government and private sectors, enterprises, and the public. As a transparent and impartial organization, TISTR is a certification body that provides services with high standard according to international criteria and has been accepted from both national and international countries. Moreover, TISTR was accredited by international standard ISO/IEC 17021-1, ISO/IEC 17065, and ISO/TS 22003. The services provided were as follows:

• Assessment service and system accreditation of international standards, for example ISO 9001, ISO14001, ISO 45001, ISO 22000, GMP (codex), HACCP (codex), TIS 18001, OHSAS 18001

• Assessment service for food production premises as TISTR is an assessing unit that has been registered with the Food and Drugs Administration (FDA) to issue a certificate for the production system standard in compliance with food law guidelines, and the examination record to be used as evidence for the renewal of food production licenses, including assessment of floor plans, production methods and lists of machineries to submit for permission from the FDA.

• Assessment service and system accreditation of agricultural commodity. The scopes that were accredited from ACFS (National Bureau of Agricultural Commodity and Food Standards) are as follows: general standard TACF 9023, TACF 9024, TACF 9041 etc. and compulsory standard TACF 1004, TACF 6401, TACF 9046 etc.

• Assessment service and system accreditation of GMP and HACCP for Q-Mark label utilization and assessment service on vegetable product manufacturing plants registered with Department of Agriculture.

• Verification and investigation of greenhouse gas. TISTR is a verification unit which was registered with Thailand Greenhouse Gas Management Organization (TGO). The service provided was verification of carbon footprint of an organization.

• Products and services accreditation including products and services in 6 categories as follows:

1) Electric and electronics products. TISTR provided assessment service and product accreditation in compliance with Thai industrial standards, IEC standards, and other related standards.

2) Biodegradable plastic product according to ISO 17088 and TIS 17088. TISTR is a certification body for green label accreditation and products made from biodegradable material (for specific purpose) and bio-based plastic product (for specific purposes) under the collaboration with Thai Bioplastics Industry Association.

3) Railway transportation system products. TISTR provided assessment service and product accreditation conforming to Thai industrial standards, ISO standards, and other related standards.

4) Good Agricultural Practice (GAP) for food plants TACF 9001. TISTR provided assessment service and product accreditation conforming to National Bureau of Agricultural Commodity and Food Standards.

5) Organic TACF 9000 Volume 1. TISTR provided assessment service and product accreditation conforming to National Bureau of Agricultural Commodity and Food Standards and other related standards.

6) Thai tourism standards according to the certification criteria in the scope of quality standards of tourism sites and tourism activities (Thailand Tourism Standard) of the Department of Tourism, Ministry of Tourism and Sports.

International Collaboration in 2020

TISTR determined and implemented the strategic direction of international collaboration with foreign partners that would improve the potential of organization and researchers as follows:

• Research and Development (R&D) relevant to the concept of Bio-Circular-Green (BCG) Economy; such as, circular waste-to-energy, circular functional agriculture, bio-based technology for economic value creation from local identity herbal plants and local resources

• Readiness preparation of human development and laboratory following the international standards OECD-GLP and GMP for providing total solution services; such as, railway and local content analysis and testing, safety food testing, biodegradable plastic testing

Universiti Kebangsaan Malaysia (UKM), Renewable Energy and New Materials Institute (REMI) and University of Science and Technology of Hanoi (USTH)

TISTR conducted R&D on energy technology following the BCG Economy Concept for the sustainable development of the country by collaborating with foreign research institutes namely

1) Universiti Kebangsaan Malaysia (UKM), Malaysia – developed the capabilities of researchers in R&D on biorefinery, biofuel, biochemical, microalgae, hydrogen production technology from wastewater, and technology for preparedness and adaptation to climate change;

2) Renewable Energy and New Materials Institute (REMI), The Lao People's Democratic Republic – conducted a joint R&D on biodiesel production technology from Tung Oil and biodiesel quality improvement technology by using partial hydrogenation method. TISTR and REMI together presented ajoint research paper in the topic: The Possible of Improvement Techniques for Oxidation Stability of Tung Biodiesel in Pure and Applied Chemistry International Conference 2020 (PACCON 2020) at Impact Arena, Exhibition and Convention Center, Thailand

3) University of Science and Technology of Hanoi (USTH), Vietnam –executed a joint research project plan in gasification technology in the form of exchange of scientific knowledge and resources; such as, materials for renewable energy production, as well as jointly created ASEAN Biomass Database.

The international cooperation in energy with the aforementioned foreign organizations was a part ofthe project underthe ASEAN Network of Excellence Centre of Biomass Conversion Technology (ANEC) in the second consecutive year (ANEC project started in 2009). The project was under thesupervision of the ASEANSub-Committee on Science and Technology Infrastructure and Resources Development (SCIRD) and funding supportby the ASEAN Science, Technology, and Innovation Fund (ASTIF). TISTR was a key organization in project implementation with the objectives to build the scientific collaboration and to exchange knowledge and transfer technology in the field of biomass conversion and renewable energy among ASEAN member countries, extended fromthe ASEAN Network on Biomass Open Research (ANBOR) projectsin 2015-2018.

the Visit of ANEC Delegation at TISTR

Collaborative Activities with REMI

Collaborative Activities with UKM

International Conference on Circular Economy and Technology Transfer for Small and Medium Enterprises (SMEs)

Illustration of Regional Workshop on Technology Transfer: Renewable Energy Technologies for Climate Change Mitigation

In addition, TISTR worked with the Asian and Pacific Centre for Transfer of Technology (APCTT) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and foreign agencies specialized in energy to organize the International Conference on Circular Economy and Technology Transfer for Small and MediumEnterprises(SMEs) in order to exchange knowledge on science, technology, and innovation (STI) under the Circular Economy Concept, as well as topromote the adaptation to climate change of SMEs at the international levelon 23 September 2020 at Bangkok International Trade & Exhibition Centre (BITEC) and Regional Workshop on Technology Transfer: Renewable Energy Technologies for Climate Change Mitigation for exchanging information on renewable energy technology and promoting international cooperation in research and application of renewable energy technologyto relieve the climate change at the international level on 24-25 September 2020 at Rama Gardens Hotel, Bangkok, Thailand.

National Institute of Advanced Industrial Science and Technology (AIST)

TISTR by Biodiversity Research Centre (BRC) in cooperation with National Institute of Advanced Industrial Science and Technology (AIST) by Health Research Institute (HRI), Japan jointly conducted the project under Joint Research Contract: Functional Analysis and Diversity of Lactic Acid Bacteria Isolated from Thai miang and Japanese Fermented Tea. The project aimed to study the change and quantity of lactic acid bacteria during the miangfermentation process, characterize probiotic properties of the lactic acid bacteria isolated, and compare biodiversity of lactic acid bacteriaisolated from Thai miang and Japanese fermented tea. In addition, the collaborative project intended to exchange academic knowledge such as novel lactic acid bacteria with potential probiotic properties or other properties like GABA production, information of microbiome during fermentation process useful for optimization of miang or Japanese fermented tea production process, sources of bioactive compound for health

benefits, and biodiversity of lactic acid bacteria between Thailand and Japan.

During 18 – 22 December 2019, Dr. Horie Masanori, Researcher from HRI, AIST together with TISTR's research officers collected 52 samples of Thai miang including astringent and sour types from the local

markets in Chiang Mai, Chiang Rai, Nan, Phrae, Mae Hong Son, Phayoa, Lamphun and Lampang. These samples were used in isolation of lactic acid bacteria and yeast, after that all isolates had been purified before studied on probiotic properties. Moreover, the study utilized extraction of Genomic DNA to learn bioactive compound. The collected miang samples can be selected as 1,200 of lactic acid bacteria, 350 yeast strains. The researcher implemented extraction of Genomic DNA from 11 samples, andalso performed preliminary identification using MALDI TOF acquired 300 strains of lactobacillus. Another result of this study was 100 strains of probiotic microorganisms undergoing red blood cell degradation properties. The study of probiotic properties was performed as following activities, 1) Antimicrobial Ability, 2) Antimicrobial Susceptibility, and found that the qualified 100 strains of probiotic had ability to resist certain pathogens and was sensitive to many antibiotics. The results of this research project can be used to further develop future research projects. Apart from the aforementioned project, TISTR and AIST by Life Sciences & Biotechnology group magnified collaborative areas to other projects. Those institutes included Plant Gene Regulation Research Group, Bioproduction Research Institute (BPRI), Biomedical Research Institute (BMRI), Cellular and Molecular Biotechnology Research Institute (CMBRI), and Health Research Institute (HRI).

Shinyei Testing Machinery Co., Ltd.

TISTR by Thai Packaging Centre (TPC) in cooperation with Shinyei Testing Machinery Co., Ltd., Japan,worked on Technical Study Cooperation on Transport Packaging Environment in Thailand. The purpose of this project was to develop academic cooperation in preparation and processing of environmental data in road transport conditions in Thailand. The data will be utilized in assessing dangerous conditions of transport roadincluding the development of knowledge of the personnel in the field of transport packaging testing through the aforementioned research studies and also used for further design and develop packaging in order to reduce the damage of the products during transportation in Thailand. The activities under this collaboration such as recording of vibration, temperature, relative humidity by Transportation Data Logger, collecting and processing of information from Transportation Data Logger into Power Spectral Density (PSD) format. The company supported on training on the instruments used to perform the experiments/collect the data and the knowledge of manipulation/interpretation the data and provide instruments needed to perform the project. For TISTR side, TPC provided knowledge and technology and also working space/laboratory for conducting the project.

In conducting this joint research, TSITR also coordinated with Thailand Post Co., Ltd. in the installation of a data recorder with a Thai Post carrier by dividing the implementation into two phases according to transport routes. In the first phases, the recorders were installed in 6 different routes: Bangkok - Ayutthaya, Bangkok - Ratchaburi, Bangkok - Lamphun, Bangkok - Ubon Ratchathani, Bangkok - Chonburi and Bangkok - Prachin Buri. The second phases were implemented in 4 routes: Bangkok - Nakhon Ratchasima, Bangkok - Nakhon Sawan and Bangkok – Songkhla. The data received from all 10 routes can be interpreted for improving packaging to suit the road transport environment in Thailand.

The TPC of TISTR has organized training to transfer knowledge and capabilities in the use and processing of data recorder instruments for implementing further activities. Furthermore, TISTR has also developed continuous cooperation with Thailand Post Co., Ltd. on packaging design and development for future services.

World Association of Industrial and Technological Research Organizations (WAITRO)

TISTR has been selected as the Asia and the Pacific Regional Focal Point (RFP) for the World Association of Industrial and Technological Research Organizations (WAITRO) between 2019 and 2020. The WAITRO's RFP was responsible for communication, promoting information about WAITRO's activities with members among Asia and the Pacific.

In the year 2020, TISTR performed activities as Asia and the Pacific's RFP, such as

- Recruiting the new members and reactivating inactive and existing members

- Participating in "Call for Water Challenges" by presenting project ideas to match with other WAITRO members. TISTR applied for WAITRO Innovation Award 2020 with two topics including (1) Water Security for Agricultural Processing via Water Recovery – TISTR and Universiti Kebangsaan Malaysia, Malaysia, 2) COVID-19 Challenge: Phytotechnologies to provide clean water in small communities – TISTR and Institute of Ecology (INECOL), Mexico. The first prize went to the second topic by judgement of WAITRO's Scientific Advisory Board (SAB).

- Collaborating with LEITAT Technological Center, Spain and Fraunhofer-Gesellshaft, Germany submitted proposal under Horizon 2020 – SFS-21-2020: Emerging challenges for soil management on the topic of Understanding the Effects of Soil Management and Climate Change on Soil Biodiversity & Ecosystem Services to Promote Evidence-Based Conversation Strategies (SOILGUARD). The topic could pass to the 2nd Stage of Proposal.

- Nominating TISTR Research Officer to join various WAITRO training programmes such as Management of Research and Development Organizations, Hygiene Product Development, Internet of Things (IoT) in the Smart Agriculture Industry, Solar Thermal Technology for Industrial Equipment, Proposal Writing for Horizon Europe project.

- Enhancing opportunities for WAITRO members to participate in various academic conferences organized by TISTR.

- Providing information on relevant regional policies, particularly on BCG Economy, to guide WAITRO's activities in accordance with member needs.

TISTR's Governorparticipated WAITRO Executive Board and RFP Meeting During 4-8 November 2020 in Botswana

TISTR joined WAITRO://50 Virtual Innovation Summit 2020 and WAITRO Innovation Award 2020
During 28 – 30 October 2020 (Online)

Partner for Your Success

TISTR Head office
Thailand Institute of Scientific and Technological Research

35 Technopolis, Tambon Khlong Ha, Amphoe Khlong Luang, Pathum Thani 12120, THAILAND
Tel : (66) 2577 9000 Call Center : (66) 2577 9300 E-mail : tistr@tistr.or.th

TISTR Bangkhen

196 Phahonyothin Road,
Chatuchak, Bangkok 10900
Thailand
Tel : (66) 2579 1121 - 30,
(66) 2579 0160

TISTR Bangpoo Industrial Metrology and Testing Service Centre

Soi 1 C Bangpoo Industrial Estate, Tambon Bangpoo Mai, Amphoe Muang, Samut Prakan 10280, Thailand
Tel : (66) 2323-1672 – 80
E-mail : mtc @ tistr.or.th

Lamtakhong Research Station

333 Vil. 12 Mitraphap Rd. Nong Sarai Subdis.
Amphoe Pakchong
Nakhon Ratchasima 30130,
Thailand
Tel : (66) 44-390107,
(66) 44-390150
Mobile : (66) 81-9994770,
(66) 87-8793330
E-mail : lamtakhong @ tistr.or.th

Sakaerat Environmental Research Station

1 Mu 9, Tambon Udom Sab,
Amphoe Wang Nam Khieo,
Nakhon Ratchasima
Province 30370, Thailand
Tel : (66) 44-009556,
(66) 86-1253793
E-mail : sakaerat @ tistr.or.th