



Innovation for Agriculture

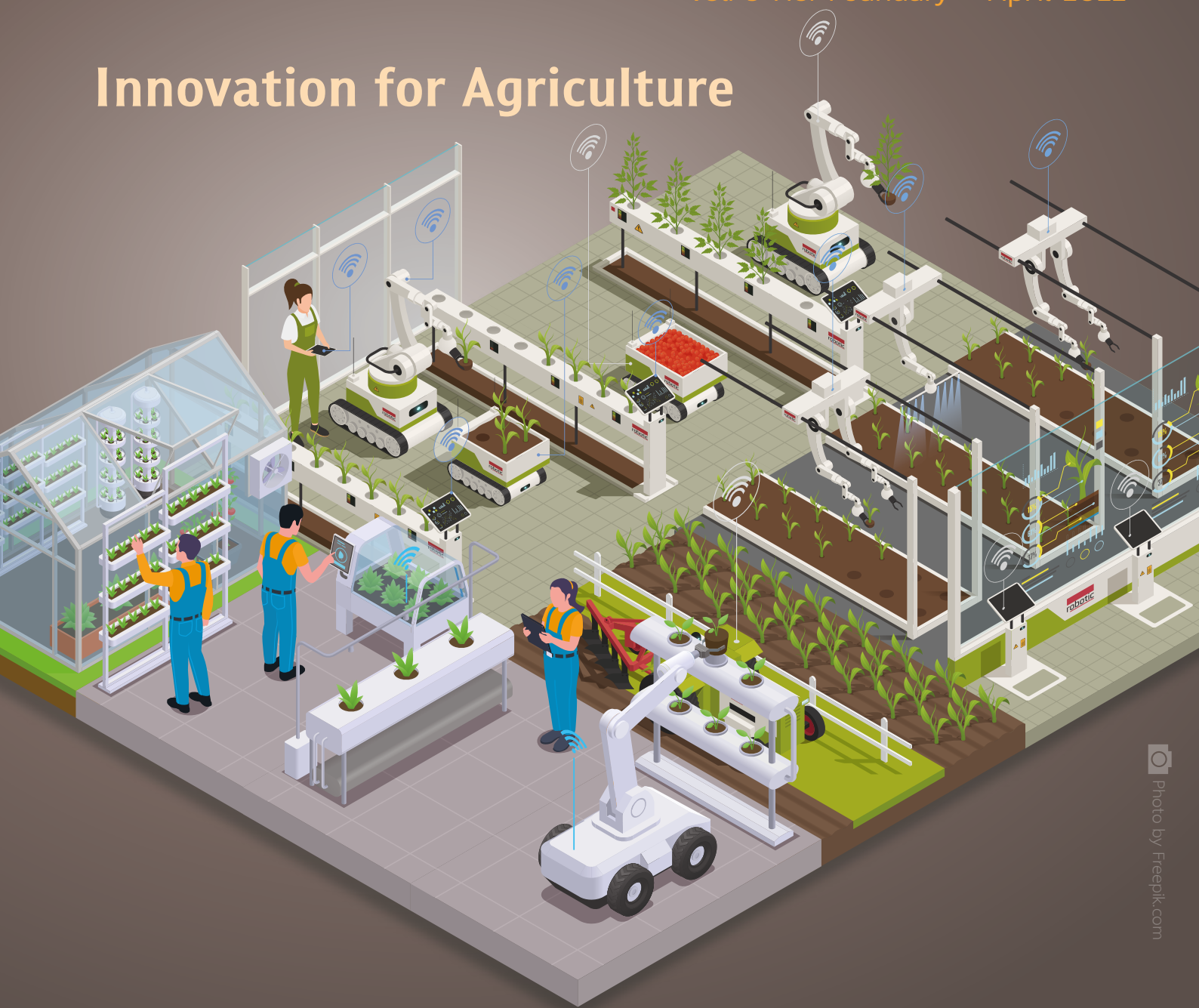


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ISSN 2465-3764



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Editor's note

Our changing environment and climate change are profoundly impacting on Thailand's agricultural sector. Traditional farming practices that rely on nature must adapt to these changes. Research and innovation will help solve the problem in the agricultural sector to enable farming in unsuitable environments, boost productivity and add value to agricultural products. This will benefit Thailand's small farmers and the broader agricultural sector.

However, adoption of these innovations will require the attention and commitment of farmers themselves, and consider the social landscape and culture as well as the tools and technologies themselves.

Thailand's strength will be to build on its indigenous wisdom through learning and adaptation through modern innovation and knowledge in the context of Thai society.

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UNISEARCH JOURNAL

Vol. 9 No. 1 January – April 2022

Published by

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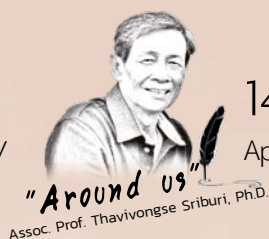
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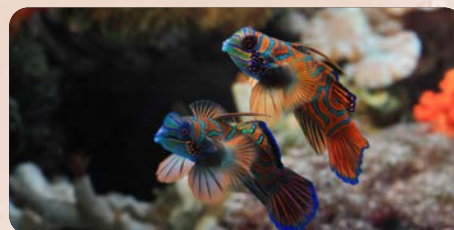
- 3
Biofertilizer Production from
Solid Waste of Cassava Starch Factory
by Microbial Consortium Inoculant



- 14 Around us
Applied Agricultural Innovation



- 4
Oral Feeding Paracetamol Pain Reliever
and Antipyretic in Postpartum Sows to
Reduce Fever and Pre-weaning
Mortality in Piglets



- 17 Project
Research on Potential Breeding and
Farming of Economically Marine Ornamentals



- 6
Pesticide Contamination Test Kits
for Water Sample Determination



- 19
Activities News



- 8
Development of High Protein
Gluten-Free Pasta



- 9
Innovative Management of Organic Waste
with Building Wastewater for Biogas and
Biofertilizer Production Using a Single-stage
Anaerobic Co-digestion with a Membrane
Bioreactor as a Zero-waste System

11 Interview

Professor Supachitra Chadchawan, Ph.D.,
Omics Sciences: Developing Research
into Agricultural Innovations



Biofertilizer Production from Solid Waste of Cassava Starch Factory by Microbial Consortium Inoculant

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Introduction

Thailand produces 12% of the world's cassava and is ranked as the world's third-largest producer. The crop is grown mainly in the country's eastern and northeastern regions. Cassava is a hugely versatile crop with a high starch extraction rate suited for both industrial uses and energy. Its resistance to drought and changes in climate have made it an increasingly popular crop, and production and processing are both expanding in Thailand, and have long outgrown their small-scale household origins to emerge as a major processing and exporting agribusiness. The industry's rapid growth led to a massive solid waste disposal problem, comprising mainly of cassava pulp and sludge from wastewater management. Solid cassava waste is harmful to the environment and must be treated correctly. One promising option is to convert the cassava waste into biofertilizer. The cassava waste is rich in organic matter and the pulp contains plant nutrients. The high-water retention capacity of the pulp allows it to retain water and slowly release for plant use. Moreover, its porous structure allows good drainage, ensuring good root aeration and preventing rotting. Because plants cannot directly utilise complex nutrients such as starch contained in the raw waste, microbial treatment is used to break them down into simple components and make them available for root absorption and crop growth.

This research was conducted by analysing components in the cassava solid waste obtained from the wastewater treatment process. The solid waste was then inoculated by microbes that are able to digest starch and cellulose. Following inoculation, nutrients were added and the treated waste was turned into biofertilizer.

Conclusion

Converting solid cassava waste into biofertilizer is a promising alternative option for waste management. Apart from reducing the total burden on local waste management systems, biofertilizer enhances crop growth, and in this research also boosted yields. Moreover, the plan for the future is to produce a leavening agent for the cassava waste biofertilizer to increase the weight of cassava tubers. The cassava waste biofertilizer will be piloted on cassava fields in the locality.

Oral Feeding Paracetamol Pain Reliever and Antipyretic in Postpartum Sows to Reduce Fever and Pre-weaning Mortality in Piglets

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Introduction

As farrowing approaches, sows may be restless and increasingly agitated. The sows are observed to exhibit nest-like behaviour as explained in sows in their natural environment one day before farrowing (Cronin et al., 1994). During and throughout farrowing, the sows should remain lying more than getting up and down. The time they spend lying down should exceed the time used for other activities such as standing and feeding. This behaviour shows a vital motherly characteristic. When the sow is lying down quietly, the piglets may access the udder for warmth and nutrition during infancy. Frequent standing in sows is undesirable and increases the likelihood of the sow laying down and crushing the piglets (Fraser, 1984). After farrowing, sows spent $89 \pm 3\%$ sleeping, with a slight decrease during lactation. On day 20, the time decreased to $78 \pm 3\%$ (Hötzel et al., 2004). Healthy sows without fever recover faster (Lammers and De Lange, 1986). Valros et al. (2003) reported that the lying down period during the third day of lactation indicated a positive trait of a good mother. It is widely known that one of the key components of the action of the antipyretic analgesic is in pain control as well as for pain relief (FAWC, 1992). Therefore, treating the sows with steroids and non-steroidal anti-inflammatory drugs (NSAIDs) can control pain primarily by reducing inflammation and swelling (Short, 1998). However, treating the sows with corticosteroids is inappropriate since it triggers immunosuppressive effects. Moreover, injecting corticosteroids during lactation interferes with milk quality, which may hamper piglet performance (Bishop, 1998).

Studies on NSAIDs in rats (Engelhardt et al., 1996) indicated that meloxicam outperformed other NSAIDs, including piroxicam, diclofenac, and indomethacin meloxicam. The oxicam class NSAID has the ability to inhibit the biosynthesis of prostaglandin (Engelhardt and Trummlitz, 1990) and inducible cyclooxygenase 2 (COX-2) (Engelhardt, 1996). Therefore, it is used as an anti-inflammatory and antipyretic (Friton et al., 2006). NSAIDs are also used for non-infectious locomotor disorders in pigs by reducing sore legs and inflammation (Friton et al., 2003) and treating complex respiratory diseases in pigs (Georgoulakis et al., 2006). It is also used to relieve postoperative pain associated with soft tissue surgery, such as castration (Keita et al., 2010). In sows, NSAIDs are used as an adjunctive treatment for Mastitis, Metritis, Agalactia (MMA) in combination with appropriate antibiotics (Hirsch et al., 2003). In this study, the researchers wanted to introduce and compare the effectiveness of the oral feeding of acetaminophen and the intramuscular injection of metamizole in sows. The criteria included fever and stress after farrowing, maternal behaviour characteristics, postnatal death rate from crushing of piglets by the mother sow, preweaning mortality, and the weaning-to-estrus interval.

Conclusion and suggestions

Administering pain reliever and antipyretic in postpartum sows for three days after farrowing allowed the sows to recover quickly. The result was apparent, especially in the group that received paracetam[®] which reduced postpartum fever. The sows were able to return to feed faster, and the amount of lactation during the first seven days was higher than the metamizole treated and control groups. Piglets in the group where the sows received analgesic drugs had lower pre-weaning mortality than the control group. Analgesic drugs reduced deaths from malnutrition, injuries and infections in the farrowing cage. In terms of cost, giving paracetam[®] to sows increased the cost by 45 baht, compare with 75 baht for metamizole. However, giving the sows analgesic drugs increased weaned piglets by 1.5 and 1 pig respectively compared to the control group. Currently, weaned piglets can be sold on the farm for 1,800 baht each, enabling farmers to generate profit per litter of 2,655 baht and 1,725 baht, respectively.

Pesticide Contamination Test Kits for Water Sample Determination

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Introduction

Thailand's economic growth rate over the past decade averaged only 3% per year, making it difficult to escape the middle-income trap and reduce inequality. The government's new 'Thailand 4.0' economic development policy aims to achieve 'leapfrogging' economic growth through implementation of the Bio-Circular-Green Economy (BCG Economy) model, with the goal of increasing economic growth to 24% of Gross Domestic Product (GDP) or 4.4 trillion baht, while also contributing to global competitiveness and supporting targets under the United Nations' Sustainable Development Goals (SDGs). The policy is also aligned with the Sufficiency Economy Philosophy (SEP), a key principle in Thailand's economic and social development.

The BCG Economy model targets development of three types of economies: Bioeconomy, Circular and Green Economies to transform Thailand's national economy, building on the country's strengths and comparative advantage, which include biodiversity and cultural diversity. The model will leverage science, technology, and innovation to boost long-term competitiveness in four target industries: agriculture and food, energy and materials, tourism and services, and health/medical industries. Science, technology and innovation will boost the efficiency of primary producers such as farmers and incentivize entrepreneurs to produce goods and services with higher added value or innovation in order to generate inclusive growth through long-term economic growth, improved income distribution, and wider job opportunities.

Transition to a BCG Economy will require a deeper understanding across various disciplines and domains, as well as a cross-cutting overview in order to achieve the expected benefits to the economy, environment and society.

Thailand has been heralded as the "Kitchen of the World" because of its rich and diverse cuisine and thriving food exports. According to the Office of Agricultural Economics, in 2017 Thailand had almost 150 million hectares of agricultural land, with the agricultural sector contributing some 10% to national GDP. Adoption of new technologies and agricultural chemicals will help increase productivity in order to boost the competitiveness of Thai food exports in the global market. (Food and Agriculture Organization of the United Nations, 2018; Office of Agricultural Economics, 2018). However, the use of agrochemicals necessitates consideration of sustainability and potential impacts on living organisms and the environment. Pesticides are intensively used by Thai farmers, with paraquat and atrazine extensively used to control weeds in the field. According to the Office of Agricultural Economics, nearly 10 million kilograms of paraquat and nearly 3.5 million kilograms of atrazine were imported in 2019. (Summary of the top 10 hazardous substance imports, 2019). Herbicide residues can be highly hazardous. Paraquat is highly toxic on contact or ingestion and is classified as a carcinogen. It is also thought to be one of the causes of Parkinson's disease (Bethsatt & Colangelo, 2006).

To avoid harming aquatic life, the Department of Disease Control has set the maximum amount of paraquat in water at 0.5 milligrams per liter. Meanwhile, the US Environmental Protection Agency has determined that maximum atrazine contamination in drinking water and groundwater must not exceed 3 micrograms per liter (Chuntib & Jakmunee, 2015). Monitoring of these substances in bodies of water is therefore critical. The inspection method must be precise and capable of measuring very low concentrations. Various analytical instruments are used including Liquid Chromatography/Mass Spectrometry (LC/MS) (Taguchi et al., 1998), Ionic-liquid microextraction in conjunction with High Performance Liquid Chromatography (HPLC) (Ou et al., 2018). Although the techniques mentioned above can detect contaminants at very low concentrations, their use is limited by high prices and the need to use a water sample collection method that minimizes the possibility of contamination.

Conclusion and Recommendations

The study revealed that measurement kits made of nanoporous carbon materials, combined with color analysis techniques were able to measure paraquat contamination using a UV-visible spectrophotometer with a Method Detection Limit (MDL) of 2.26 micrograms per liter. A method quantitation limit test with a limit of 7.46 micrograms per liter perceived as yellow-orange color and can measure atrazine with the naked eye in the range of 1-5 micrograms per milliliter. The researchers will continue to investigate the surface chemistry of porous carbon materials in order to apply to other chemicals for maximum benefit.



Development of High Protein Gluten-Free Pasta

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Introduction

Pasta is available all around the world in its diverse forms. Most of the pasta were made from wheat flour. Wheat pasta contains gluten protein, which gives the desirable elastic texture. However, due to gluten allergy awareness, many attempts have been made to develop gluten-free pasta products, which are mostly produced from rice flour. In comparison with wheat pasta, rice pasta is still considered inferior, mainly because of the lower elasticity of the cooked pasta as well as its lower protein content. Numerous ingredients including animal-derived proteins (albumen and whey protein), and plant-derived proteins (soy protein), hydrocolloids (xanthan gum and guar gum) as well as modified starches can be added to improve texture, cooking quality and nutritional quality of rice pasta. Although soy protein is regularly used in many types of food products, the major disadvantage is its allergenicity. Mung beans offer an alternative to soybeans, with some unique properties. Mung beans are not only high in protein but also possess high amylose starch, which may help improve the texture and cooking quality of gluten-free pasta. Unlike soybean, mung bean is not included in the list of "Big 8" food allergens. Nevertheless, research studies regarding the application of rice and mung bean as main ingredients in gluten-free pasta are still limited. The objective of this research project was to determine the most appropriate formulation and processing conditions for production of high protein gluten-free pasta. Rice flour was used as a main ingredient, with mung bean flour and mung bean protein concentrate added to enhance protein content. The pasta was made via extrusion process. The final product, with its higher protein content and zero gluten, offers a good alternative for person with a gluten allergy as well as other health-conscious consumers.

Conclusion and recommendations

The major outcomes from the research were the appropriate formulation and processing condition to produce high-protein gluten-free pasta. The final product contains rice as a major ingredient, fortified with mung bean-based ingredients, which boosts the final protein content of the pasta to 20%. The final product has a high potential for upscaling to industrial scale production. However, further investigation including appropriate packaging, damage tolerance during product distribution and shelf-life estimation are still required for this newly developed pasta product.

Innovative Management of Organic Waste with Building Wastewater for Biogas and Biofertilizer Production Using a Single-stage Anaerobic Co-digestion with a Membrane Bioreactor as a Zero-waste System



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Introduction

The increasing quantities of waste generated by modern lifestyles carry huge environmental and social consequences, affecting the air, water and soils, and reaching even the most remote corners of the globe. Effective management of all categories of waste is needed at their source in order to reduce, reuse or recycle waste and minimize environmental problems. According to the Pollution Control Department (PCD, 2017), Thailand generates 17.6 million tons of organic waste annually, representing 64% of the country's total waste production. Transforming organic waste to provide a source of renewable energy and organic fertilizer offers a promising route to an environmentally friendly approach to waste management.

Educational institutions produce large quantities of organic waste, mainly from food cafeterias; most of this is biodegradable. Food waste can be treated by digestion under anaerobic conditions together with sludge from the building's wastewater treatment system. This process produces biogas and liquid bio-fertilizer. Wastewater often contains impurities in the form of organic matter and nutrients as important constituents. As a result of this biological and chemical load, discharge of untreated wastewater causes serious deterioration of water quality in downstream water systems. Therefore, the research team developed a system to recycle wastewater from buildings by treating with fermented wastewater obtained from a single-stage organic waste anaerobic digestion system. It is a zero-waste system for reusing nutrient wastewater in the form of liquid bio-fertilizer to reduce the volume of wastewater at source and to enable recycling of water resources. The research was supported by the Japanese JICA Water Reuse Project and the Office of Physical Systems Administration, Chulalongkorn University.

Conclusions

Liquid biofertilizer produced from membrane bioreactor systems in the co-treatment of wastewater from building and liquid digestate from organic waste composting bin has met all defined quality parameters for water recycling for non-food crops and landscape water as specified by U.S. EPA (2012). It can be used to water gardens and for landscape architecture work as well as offering an alternative, environmentally friendly system to manage and conserve water. This is particularly important as water scarcity and drought becomes increasingly common, reducing the need for abstraction from natural water sources.



Omics Sciences: Developing Research into Agricultural Innovations



Professor Supachitra Chadchawan, Ph.D., is the Director of the Bioinformatics and Computational Biology program, lecturer at the Department of Botany, and Assistant Dean of the Faculty of Science, Chulalongkorn University. Her research specializes in plant stress physiology and molecular biology. She proposes a guideline on developing omics science research into practice to solve problems in the agricultural sector of Thailand and achieve sustainability.

The importance of omics sciences in the development of agricultural innovations

"...Omics sciences give us new insights into living organisms and how they interact, unlocking the path towards practical innovations in agriculture..."

Omics sciences refer to a scientific discipline which studies biochemistry and molecular biology, including existing technologies and some more recent ones such as epigenetics and metagenomics for studying microbiota, with advances in computational solutions applied to bioinformatics. The suffix -ome is added to signify this holistic integrative approach to studying biological data through different lenses. For example, a collection of data relating to genes is referred to as the genome, while the collection of data on proteins is known as a proteome. Aside from an understanding of multiple fields in biology, a knowledge of bioinformatics is needed to understand, organize and process large volumes of data. In the past, these disciplines were separately investigated. Today, advances in computing power unlock the opportunity through omics sciences to combine data on these processes in a holistic way to gain new insights into how organisms function. For instance, organic farmers might need all data about microbes. In the past, scientists would need to study each specific microorganism, whether related to agriculture or not. The omics approach enables scientists to build a more holistic picture and allow innovations to be tailored from unprecedented perspectives. Omics sciences give us new insights into living organisms and how they interact, unlocking the path towards practical innovations in agriculture. Decoding a plant's genome using conventional methods could take ten years, while with omics sciences, genomic data can be quickly generated. Omics sciences are a holistic approach to studying organisms to get a more precise and accurate picture in a shorter time. Understanding this technology may also lead to discoveries that enhance Thailand's agricultural sectors and sustainable development.

Research trends, directions, and the extension of agricultural innovation

"...To bring omics-based science to foster innovation, it is vital to invest time in talking with real-world users about their challenges and needs. Based on these insights and a comprehensive needs analysis, researchers can then design new tools and approaches tailored to their needs and capacities as a first step towards developing agricultural innovations..."

Thailand's abundant natural resources and biodiversity offer immense potential for bio-innovation, and many organisms related to agriculture have yet to be studied. If Thailand is to keep pace with technology, omics technology can help find answers and open different perspectives towards practical innovations in agriculture. This will require a broader knowledge of the principles of omics sciences across the research community in order to realize its potential. Users are also need to be engaged with partners. To increase the pool of knowledge, investment in education is needed as well as improved access to searchable agricultural and genomic data covering diverse environments. Open access to data must also be ensured to foster interest among young researchers, facilitate access and unlock the potential of omics studies in agricultural research. Omics sciences require a background in biology combined with strong bioinformatics and computational skills– still a relatively rare combination in Thailand, with relatively few opportunities and graduates in this field, when compared with the number of researchers in some countries.

Limitations in research, development and practical application

"...Thailand's lack of expertise in omics sciences limits application for agricultural research, while limited coordination among biologists and computer scientists represents an additional roadblock. Omics will require significant new investment and a platform to communicate among real-world users and researchers..."

Thailand urgently needs to overcome two key barriers– fostering a new generation of experts with the required multi-disciplinary skills; and creation of a platform to foster communications across key disciplines and with practitioners such as farmers or companies related to agricultural industrial, who represent target groups. Investment is needed today to enable the country to address these challenges. Open access to global databases and datasets will help reduce the investment required to implement omics sciences effectively in Thailand, though localizing such data to ensure their relevance and practicality to specific environments in Thailand carries significant budgetary implications. Investment and funding may be addressed though both public and private sectors.

The need for a communication platform to connect researchers and users is also clear. Such a tool will enable clear and specific identification of real-world problems, articulation of research questions and potential methodological approaches available through omics sciences. Private sector investment should undoubtedly be fostered to complement public funding to meet farmer needs and fill research gaps. In this regard, it will be vital to ensure open data access and avoid proprietary capture of genomic data by private companies.

I would like to share an example of a research study using omics sciences in agriculture. A salinity-resistant rice variety was developed based on sequencing the genome of Thai rice cultivars. Transcriptomics was then used to identify the salinity-resistant genes, which was a more cost and time-effective approach than using conventional genomics to develop a genetic marker to enable marker-based selection and speed up conventional selective breeding. These published findings will help other researchers adopt similar approaches to address comparable research problems. In another example of research by NSTDA, researchers used proteomics to identify the protein responsible for drought-resistance in a specific rice variety. Identifying the gene that controls protein expression was a major step to understand and exploit the mechanism in rice as well as introduce drought resistance traits into other varieties and crops. Gene editing tools such as CRISPR-Cas can precisely modify the specific gene to introduce the desired trait such as drought or salinity tolerance. The next step of omics research will determine the optimal methodologies; however, the research process is lengthy and complex. Omics sciences can be used to study data captured via conventional methods and identify genetic markers. The approach can enhance our understanding of many different biological mechanisms and even catalyze the emergence of new fields of research that can accelerate innovation for agricultural development.

Towards sustainability: challenges for education and research

"...Thailand needs to produce more omics research professionals and unlock new research opportunities to keep pace with changing technology. As a premier tertiary education institution, Chulalongkorn University, has already begun to expand its omics science courses to help Thailand gear up to address this challenge and this opportunity..."

As Thailand enters a new era of information-based science and technology derived from new methods and technologies, Thailand faces a growing challenge to keep pace with global change. If it goes well, it will definitely be a point to strengthen the country's future. In this transition period, Thailand needs to produce more omics research professionals and unlock new research opportunities to keep pace with changing technology. As one of Thailand's top tertiary education institutions, Chulalongkorn University has already begun to expand its omics science courses to help Thailand gear up to address this challenge and this opportunity. However, future growth in omics sciences is constrained by limited data and relatively low visibility of this emerging field in the academic world. It may therefore be necessary to establish a national roadmap to foster expansion, and particularly to facilitate access to 'big data' and incentivize omics sciences as a career option. For example, the government could encourage companies to broaden understanding of the field by deploying their research personnel to learn about omics science in agriculture. Government could also allocate a budget earmarked for omics-based research to develop agricultural innovations that contribute to a thriving, competitive and sustainable agricultural sector.



Professor Supachitra Chadchawan, Ph.D., graduated with a bachelor's degree in science (DPST scholarship) in botany from Chulalongkorn University and a Doctor of Science (Anandamahidol Foundation Scholarship) in Botany from the University of Washington, USA. She was nominated to the "DPST Hall of Fame" in 2020. She specializes in plant stress physiology and molecular biology, chitosan and plant response, and the effects of silver nanoparticles on plants.





Applied Agricultural Innovation

Farmer innovations are rarely recognized. Farmers and villagers originally developed the practice of incorporating charcoal made from wood waste into the soil to enhance crop productivity. However, until recently there was no effort to improve the characteristics of charcoal to boost its ability to retain fertilizer and water, thus reducing the need for expensive chemical fertilizers. Studies conducted since 2011 indicate that biochar can store nutrients from fertilizers added to the soil and reduce fertilizer requirement for at least three years or planting cycles.

Meanwhile, incorporating biochar into the soil reduces the amount of carbon released into the atmosphere; this sequestration of carbon in the soil is an important mechanism to combat climate change. Moreover, biochar offers an effective way to dispose of large amounts of agricultural wastes such as crop residues produce every year.

Biochar production is attracting increasing attention from researchers who have demonstrated the advantages of using biochar in agriculture. Biochar is now manufactured for commercial purposes. However, farmers will adopt such innovations only when they are convinced of their cost-effectiveness and economic benefits.

Thailand's agricultural sector plays a vital role in the national economy and society because it is one of the world's most important agricultural production bases. Agriculture employs over 12 million people or 6.8 million households, accounting for 31% of the labor force in the country (National Statistical Office, 2018). However, the agricultural sector accounts for only 8.7 % of total GDP (2017 data). Agricultural GDP has been in decline for the last decade as the sector is confronted with new challenges such as finite resources, climate change impacts, increased severity of pest and disease infestations and rocketing costs of inputs such as pesticides and fertilizers. The prevalence of traditional farming with low productivity results in very low incomes for Thai farmers. The younger generation is therefore turning its back on farming as an arduous and increasingly unpredictable vocation. Compounded by the transition to an aging society, abandonment and consolidation of agricultural lands are on the rise.

Rapid urbanization places pressure to produce more from a diminishing area of agricultural land, even as demand increases due to population growth. However, there is a parallel awareness among policymakers and consumers of the need to reduce the social and environmental footprint of food production, as well as a higher concern over food safety. The shift towards sustainable agriculture is growing fast in order to address this need and use our finite natural resources more responsibly. The contribution of farming to climate change, as well as the need for ecosystem conservation and post-harvest waste minimization in our agricultural systems are all important elements addressed by sustainable farming methods.

Agricultural innovations offer solutions and approaches to address these and other issues. Convergence of cutting-edge agricultural technologies has given rise to the emergence of 'smart-' or 'precision farming', urban agriculture and sustainable agriculture. Innovation is as a result driving a transformation that without a doubt, will be the agriculture of the future and the cornerstone of efforts to maintain and strengthen Thailand's position as the 'Kitchen of the World'.

As part of this transformation, Thailand's agricultural sector must shift its focus towards adding value and increasing sustainability by harnessing technological innovations to boost productivity and meet increasing demand. Agriculture today faces increasing expectations from society to strike a more acceptable balance between productivity, resource use efficiency and climate/environmental impacts. Farming systems will also be fundamentally disrupted by global megatrends such as biotechnology, genome technology, digital technologies, robotics, machine learning, Big Data and satellite-based sensing technologies. These technologies have the potential to transform traditional farming to create a modern, efficient and increasingly profitable agricultural sector, supported by innovative business models and methods, product development, and new agricultural services.

Integration of information technology is at the heart of agricultural innovation. Biotechnology and other modern agricultural technologies are being combined with traditional agriculture to improve cultivation efficiency, yields, and produce quality. By capturing farm data on a large scale, AI and geo-spatial approaches can be used to assist in decision-making, optimize inputs at a micro-level, and manage the crop, including post-harvest management to maximize quality and prolong shelf life.

In adapting modern technological innovations to Thailand's agricultural sector, the following prerequisites will be important:

1) Crop cultivation technology

Develop expertise in production of future economic crops such as renewable energy crops for biofuel, medicinal plants, organic farming and ornamental plants.

2) Smart farm management

Develop skills in smart farm planning, design and management using modern tools such as data measurement equipment, both on-farm and remote (via aircraft and satellite), weather stations, Global Positioning System (GPS) and Geographic Information Systems (GIS), within the farm, farm data communication system and a wireless agricultural information network, driven by networked sensors (Internet of Things, IoT) and connected to powerful data-driven clouds-based databases and decision guidance tools, enabling farm optimization decisions and high-precision crop management by autonomous agricultural machinery.

3) Agricultural produce management

Enhance efficiency of agribusiness models, including business management and development, information systems, advanced postharvest handling and packaging of produce for extended shelf life, as well as supply chain logistics for produce procurement and transportation, compliance with food safety and other legislation and export standards.



Clearly, agricultural innovation will play a crucial role in Thailand's agricultural transformation, integrating traditional farming methods with technological advancement and ensuring a balance between profit, environmental conservation and social impact to drive renewed sector growth.

Farmer participation in development of tech-enabled systems will be vital to ensure that farmers and society can truly benefit. This will help wider uptake of the innovations and avoid unintended negative consequences. Farmer-testing of innovations will be vital to ensure real-world viability and foster familiarity among target farmers for future adoption.

Indeed, agricultural innovations may not be the only lens through which to view modern technology. One must also consider how best to harness the technology to optimize resource use and returns within a social context. Farmers must therefore be educated at all levels. Finally, it will be critical that relevant government agencies invest immediately in a national agricultural transformation so that Thailand's farmers can boost their productivity, earn more money, and have a better quality of life.



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Research on Potential Breeding and Farming of Economically Marine Ornamentals



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Since ancient times, commerce in marine ornamentals mostly obtained directly from natural coral reefs has provided a source of income for many fishing families worldwide. Marine animals that are vital to ecosystem health and integrity have been harvested to serve the lucrative demands of the global marine aquarium market. The animals are illegally caught with destructive capture techniques such as explosives and chemicals. These methods have massive and often irreversible detrimental impacts not only on the target species but also on biodiversity, ecosystems, the natural environment and populations of other organisms. Many coral reefs around the world are exploited and threatened by anthropogenic activities such as overfishing, destructive fishing techniques, poaching of protected marine animals and coastal development involving the construction of tourist moorings and commercial ports. Pollution by marine plastic litter generated from these activities is a major and growing threat. Therefore, research on the sustainable breeding and farming of popular marine ornamentals, as well as less well-known species, offers a pathway to reduce the pressure on natural populations.

The National Research Council of Thailand (NRCT) recognizes the importance of this research area and has granted funding to **Chula Unisearch** for the project entitled ***“Research on potential breeding and farming of economically marine ornamentals for supporting the marine ornamental market and reef tanks.”***

The purpose of this study is to conduct research and develop techniques for the sustainable breeding and farming of marine fishes found in shallow coral reefs in the main study area, Ko Sichang, Chon Buri Province. These marine species will become economic ornamentals and boost the marine aquarium trade and reef tanks in both domestic and export markets. New breeding and farming techniques will mitigate the problems caused by poaching on coral reefs, thereby minimizing adverse impacts on biodiversity and coastal ecosystems. Less well-known marine fish species can also be developed as new marine ornamentals for domestic and global markets.

This study will focus on applying research and technology to commercial practices in Thailand to introduce new soft coral and ornamental fish species as new ornamentals. Marine species with the potential to become economic ornamentals of Ko Sichang, Chon Buri will be targeted for the marine aquarium trade and reef tanks. Broodstock; which including *Abudefduf vaigiensis*, *Naso elegans*, *Pomacanthus annularis*, *Heniochus acuminatus*, *Chelmon rostratus*, *Dascyllus aruanus*, *Bathygobius fuscus* and *Pomacentrus similis*; will be collected and breeding and culture techniques will be developed to boost the commercial prospects for marine ornamentals. The methodology will be as follows:

- 1) Select target species as popular ornamental species that are marketable, abundant in the area, and have potential for development into new economic ornamentals to satisfy the commercial marine aquarium trade and aquarium business.
- 2) Select target ornamental species with the potential for breeding and farming as new economic ornamentals of Ko Sichang, Chon Buri.
- 3) Collect broodstock of the targeted ornamental species from shallow-water coral reefs and develop broodstock conditioning and culture techniques in the incubation house.
- 4) Conduct research to develop breeding and culture techniques for the target ornamental species, including duration of culturing from larva to the juvenile stage.
- 5) Conduct market research on the economic feasibility and cost-benefits of new breeding and farming systems for the target species.
- 6) Transfer knowledge and know-how on new breeding and farming techniques to target groups such as raisers of marine ornamentals and traders. Knowledge shared will include selection of marine ornamental species, collection of broodstock of target marine ornamentals in the incubation house, techniques for breeding and culturing larvae in the aquarium and packing and transportation of juvenile fish.

This project is ambitious. Results will enable entrepreneurs in the marine aquarium trade and reef tanks to sustainably farm fish breeds for both domestic and export commercial aquaculture.



Winners of the Young Architect ECO Home Contest

On Thursday 4 November 2021, the Power Development Fund, the Energy Regulatory Commission (ERC) together with **Chula Unisearch** announced the winners of the **"Young Architect ECO Home Contest"** at CU Centenary Park, Chulalongkorn University. Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch presented the project, while Assist. Prof. Sarayut Supsook (Assistant to the President for Student Affairs at Chulalongkorn University) announced the competition winners in his capacity as director of the project. The winners were honoured by Bantoon Settasirot, Ph.D., a commissioner of the Energy Regulatory Commission who presided over the ceremony and presented prize money and trophies. The winners of the ECO Home Contest designed eco- homes with usable space in categories under 150 and under 300 square meters. The top designs will be developed and used as a standard guideline for construction available free for download by contractors and the general public.



SDG 14 Life Below Water Seminar

September 2021: The National Research Office (NRCT) joined hands with the Department of Marine Science, Faculty of Science, Chulalongkorn University, and **Chula Unisearch** to host a series of Zoom talks on **SDG 14: Life Below Water**: Conserving and Utilizing Oceans and Marine Resources for Sustainable Development. The seminars covered four important topics: 1) Marine debris and microplastics: current research and techniques;

2) Thailand and a future for coral restoration; 3) Current coral reef restoration in a changing world, and 4) Science for sustainable use of the ocean: SDG 14 life below water. The seminar aimed to create opportunities for researchers from Thailand and overseas to exchange knowledge, experience and academic expertise, as well as promoting collaborative research at national and international levels. It is envisaged that the results can be used to benefit national development, both economically and socially, as well as creating guidelines to conserve Thailand's natural resources and benefits from their sustainable management.

Closing Ceremony of the Business Transformation Training

On 2-3 December 2021, The Electricity Generating Authority of Thailand (EGAT) together with **Chula Unisearch**, organized the closing ceremony for a training course on **"Business Transformation"** (Batches 1 and 2) at the Pathumwan Princess Hotel, Bangkok. Assoc. Prof. Chackrit Duangphastra, Ph.D., Program Director, presided over the ceremony and awarded certificates and 'Phra Kieo' pins to the successful trainees. The courses enabled



trainees to gain essential knowledge and understanding of ever-changing management issues in both external and internal contexts. Moreover, they were also equipped with management and operational skillsets that can be applied and integrated to effectively create innovations for the energy sector.



Educational Visit from the Faculty of Medicine, Chulalongkorn University

Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch, recently welcomed the management team and staff from the Chula Soft Cadaver Surgical Training Center (CSSC), Faculty of Medicine, Chulalongkorn University on an educational visit to **Chula Unisearch**. The study visit aimed to promote an exchange of knowledge and experiences in academic services and organizational management, especially in the areas of procurement, finance, supplies, budget, and human resources.

Knowledge gained from the visit will be used as a guideline for CSSC to develop and improve the efficiency and effectiveness of their own operations, treasury function, asset management and human resource management.



The Remembrance of His Majesty King Bhumibol Adulyadej the Great

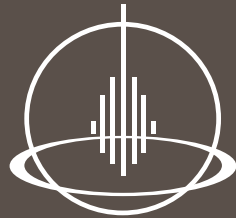
On Wednesday 19 January 2022, Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch, Chulalongkorn University, participated in a ceremony in remembrance of His Majesty the late King Bhumibol Adulyadej the Great, and an alms-giving ceremony on the occasion of the 60-year anniversary of the 'Jamjuree' trees, which are rain trees planted by the late King Bhumiphol. The ceremony was held at the Jamjuree courtyard and around the flagpoles in front of the Chulalongkorn University Auditorium.

36th Anniversary of the Establishment of Chula Unisearch, Chulalongkorn University

On Monday 14 February 2022, Supichai Tanjaitrong, Ph.D., Managing Director of Chula Unisearch, together with Deputy Managing Director Assoc. Prof. Chairat Wiwatwarrapan, Prof. Suchana Chavanich, Ph.D., Assist. Prof. Saowanee Wijitkosum, Ph.D., and representatives of **Chula Unisearch** staff made merit offerings to the sick monks at the Priest Hospital. The event marked the 36th Founding Day anniversary of **Chula Unisearch**.







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