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Sustainable Agricultural Development

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Editor's note

Thailand is blessed with abundant land and natural resources, which serve as a foundation of the country's highly successful agricultural sector. Moreover, Thailand's biodiversity represents an important resource of natural capital to support national development. However, the sector faces numerous challenges such as high production costs, low farm incomes and productivity, labour shortages and excessive reliance on farm chemicals. The environmental impacts of intensive farming include environmental contamination, loss of soil fertility and harm to human health, combined with accelerating impacts of climate change, Thailand's agricultural sector and food security are under threat.

To address these challenges it is therefore vital to transform Thailand's agricultural sector to prioritize our precious and irreplaceable ecosystems, conserve our environment and ensure resilience to climate change impacts. Thailand is attempting to develop a sustainable agriculture system by harnessing new technology, innovation and research. Important gains can be made to conserve soil fertility and water resources, increase farm productivity, and adapt cultivation patterns to a changing climate. In the livestock sector, there is considerable room to improve more efficient and sustainable feed formulations, improved husbandry methods, including managing agricultural waste. Across the board there is a critical need to create additional added value as far upstream as possible within the supply chain. Innovation and technologies are readily available; however, it is critical to support the transfer of such knowledge, technologies and opportunities innovations to empower small farmers to adopt and participate in their benefits. This must not be overlooked, because technology is never scale-neutral and small farmers unable to adopt new approaches will be unable to compete with larger, capital-intensive corporate actors. Thailand has immense potential to unlock new commercial opportunities to tap into its agro-biodiversity and combine the application of modern knowledge with traditional local wisdom, to create a unique competitive advantage for Thailand's agricultural development.

Editorial Board

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Content

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Development of Product Innovation to Improve Thai Pork quality

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Introduction

Thailland's pork industry has been modernized and improved to be more efficient, including housing, breeding and nutrition, as well as management to prevent and control disease and ensure biosafety and animal welfare. The industry aims at ensuring all nutritional requirements are met to maximize live weight gain, optimize carcass condition and enhance taste and texture of pork meat.

Pork production involves weaning, growing, and fattening to a weight of 100-110 kg before slaughter. Meat quality concerns arise because, by nature, heavier pigs have a higher proportion of fat than muscle. This undesirable trait reduces the proportion of red meat, leading to lower market prices. To compensate, some producers adjust the feed recipe and use dietary supplements such as beta-agonists. Such supplements are banned due to known adverse effects on consumers. Despite this, producers are incentivized to continue with the practice due to strong consumer preference for minimum fat, soft texture, deep red colour and low levels of intramuscular fat. Butchered pig prices are therefore closely linked to appearance, which leads producers to seek any solutions to their production and marketing needs that confer market advantage.

Inorganic dietary supplement products such as chromium picolinate, sodium selenate, and other minerals such as magnesium, manganese, and iron have traditionally been used legally. However, these are expensive as imported products, and thier benefits are still inconsistent.

To address this public health concern, the researchers collaborated with private companies to study development and feasibility of introducing organic food supplements to improve the quality of Thai pork. This quasi-academic research aimed to enable farmers to produce quality meats without using prohibited substances, thus benefitting both farmers and consumers, and enhancing the good standing of Thailand's pork industry in complying with global standards.

Small and medium-sized pork producers sometimes use feed supplements to boost quality of fattened carcasses, which otherwise would reach lower prices due to significantly higher back fat, thick belly fat, and less red meat. A study in the United Kingdom discovered a means to reduce intramuscular fat (IMF) to less than 1% in the carcass with thinner back fat which had inverse effects on tenderness and juiciness of lower muscle; however, the resulting meat quality was not favored by consumers. The optimal range of IMF should be from 2% to 3% (DeVol et al., 1988).

On average, production cost is no more than 50 satang per kg of the pig weight. However, the market has yet to accept a premium price for premium meat. Therefore, farmers are forced to absorb higher costs to maintain meat quality to meet market needs. Farmers thus have an incentive to use feed supplements to enhance meat quality at lower cost, resulting in higher market price and profitability.

The researchers hope that innovative animal feed supplements to improve the quality of Thai pork will contribute to food safety as well as carcass quality and profitability. This study can also facilitate students' learning and knowledge transfer to the industry. In turn, this will help drive sustainability in the country's broader agriculture sector.

Conclusion and suggestions

The study found that 10 g/kg feed of the new feed supplement had similar effects on the growth of the early and late fattening stages compare to unsupplemented group. Moreover, levels of back fat and LSQ of pigs in this group indicated a slight improvement. No differences were found in pH, shear force, meat color and sensory tests between treated and untreated pigs.

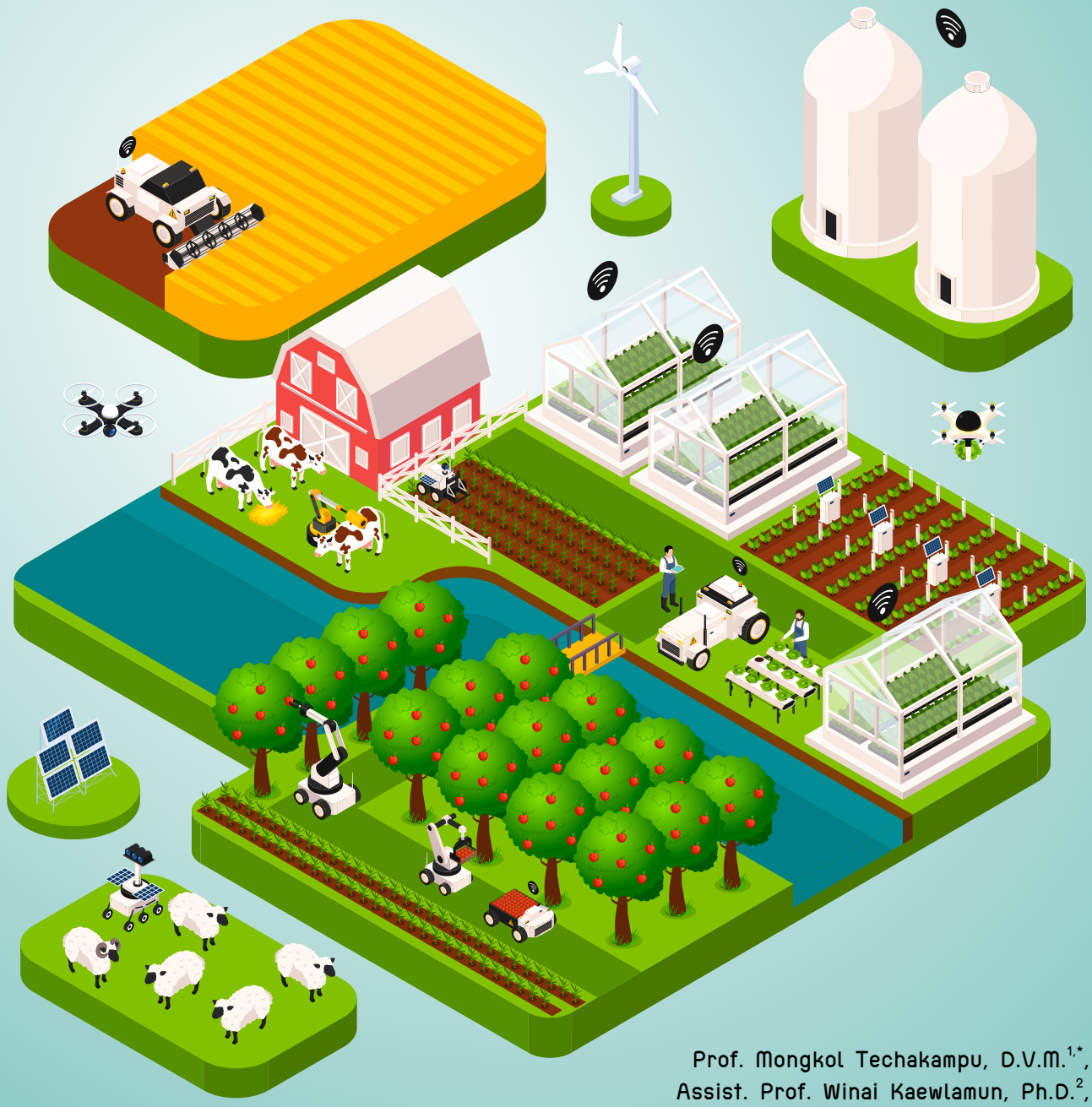
The study's results shed light on several factors relevant to improving efficiency of pork production. Suggestions for further studies are listed below.

- How to boost appetite after weaning
- How to enhance protein digestion during the growth stage in order to increase muscle mass during the late fattening stage.
- Can we find methods to continuously adjust fat metabolism to improve meat texture and quality?

Improvement of pork quality is an indicator of better animal health and welfare, and enables growth according to the animal's full genetic potential. High quality meat can be more marketable, profitable and can contribute to building a reputable, trusted brand in the market. Ultimately, consumers benefit from high quality, tasty, nutritious and safe pork.

An example of a new brand

The Pilot Project on Creating a Model for Small Ruminant Production for Small Farmers - from Small Farmers to Smart Farmers: "Livestock that Moves Mountains"



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Introduction

Nan is a province on the eastern side of the upper northern region bordering the Lao People's Democratic Republic. A permanent border control point is located on the Thai-Lao border at Huai Kon at Huai Kon Thai-Laos Transit Point in Chaloem Phra Kiat District, Thailand and Muang Ngeun, Sainyabuli Province, Laos. The transit point allows cross-border trade between the two countries. Nan is a mountainous province, with elevation ranging from 600-1,200 m above sea level. Administratively, the province comprises 15 districts, 99 sub-districts and 890 villages. Its local government consists of a provincial administration organization, a town municipality, 18 subdistrict municipalities and 80 subdistrict administrative organizations.

Data from the Office of Agricultural Economics indicates that 85% of Nan's entire population earn their living from the agricultural sector, making it the province's primary source of income. The most important economic crop is maize. In the 2014/2015 production cycle, maize accounted for 790,000 rai of the province's total agricultural area of 1.4 million rai. Total production was over 400,000 tons (Post Today, 2015). Currently, maize cultivation in Thailand covers approximately 7.03 million rai, with 64.16% of production located in the Northern region. Nan province ranks second highest in terms of its maize area. However, maize cultivation carries serious environmental impacts resulting from forest encroachment and burning of forests and crop residues. Air pollution and forest destruction and associated animal habitats continue to damage human health and local ecosystems. The forest area in Nan has decreased by 28%. Within the past five years, the damage to the forests amounts to more than 100,000 rai per year (Figure 1).

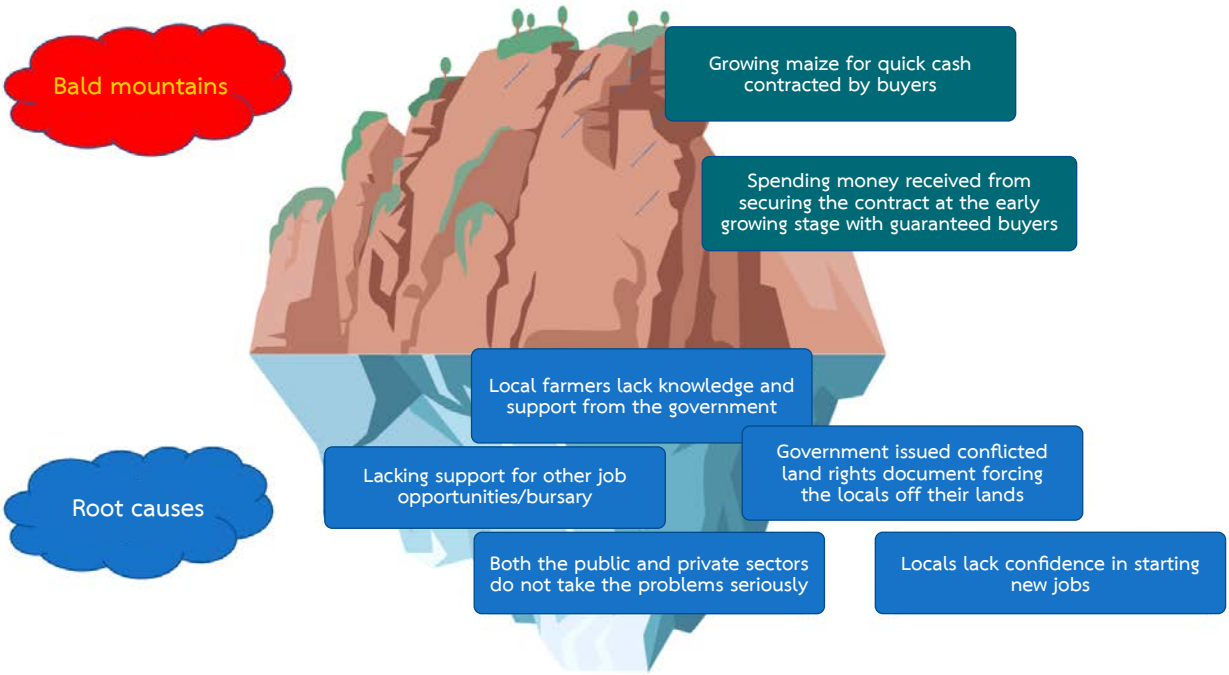

Figure 1 'Bald Mountains' and the root causes

Source: Mongkol Techakampu, designed in January 2021.

The Pilot Project on *'Small Ruminant Production for Small Farmers - From Small Farmers to Smart Farmers'* aimed to provide Nan people with an alternative livelihood opportunity as livestock farmers rather than relying solely on monocropping of maize. The project focused on working with local farmers, local farmer leaders and local government officials to develop their knowledge and skills. Nan province was chosen as a pilot area, and the project was implemented in seven districts and ten subdistricts, starting with 58 sheep herders. Goats and sheep, which are easy to rear and manage with low investment cost, were selected for this research. If this project succeeded, it would be considered for implementation in other parts of the country. The ultimate goal of the project is to provide farmers with sustainable livelihoods, while reducing deforestation and damage to the environment.

Conclusion

Using alternative livestock farming to replace monocropping is an ambitious goal that needs to be communicated and understood. The process should be done via participatory group sessions. The project should utilise the problems that farmers face and focus on their needs since these can be used as a tool to drive the project and increase further uptake. The model and guidelines for the *"Livestock that Move Mountains"* should be created through collaboration among university researchers, academics, local authorities and local communities and farmers. The model should be distributed if it yields positive outcomes.

Supplementation of Cinnamon Oil in the Lactation Diet to Improve Sow Feed Intake Postpartum, Sow Milk Yield and Piglet Growth Rate

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Photo by unsplash.com

Introduction

A sufficient daily feed intake of lactating sows is important for milk production (Vadmand et al., 2015; Pedersen et al., 2019). A low feed intake not only decreases milk production and milk quality of lactating sows (Quiniou and Noblet, 1999), but also negatively affects piglet performance (Hawe et al., 2020). Pre-weaning piglet mortality is one of the most important problems in commercial swine herds, and piglets with low body weight have a lower survival rate before weaning (Nuntapaitoon et al., 2018). Sow milk yield is the most important limiting factor for piglet growth rate (Farmer et al., 2015). Hawe et al. (2020) demonstrated that sows that consume more feed during lactation have a greater derived milk yield and heavier piglets at week 3, 4, 5 and 7 than sows with lower feed intake during lactation. Piglets reared by sows offered a high feed allowance during lactation expressed greater relative growth pre-weaning than piglets reared by sows offered a low feed allowance during lactation. Moreover, piglets with a low birth weight reared by sows with a high feed intake have a tendency to have a lower pre-weaning mortality than low birth weight piglets reared by sows with a low feed intake during lactation. Therefore, improving daily feed intake of lactating sows can improve both sow and litter performance.

In tropical conditions, heat stress is the main factor affecting sow appetite; specifically, heat stress decreases daily feed intake (Black et al., 1993; Quiniou and Noblet, 1999; Bergsma and Hermesch, 2012). Lactating sows exposed to high temperature and high relative humidity exhibit reduction in their voluntary feed intake (Renaudeau et al., 2001). Feed intake also affects sow body weight loss during lactation, decreases milk production and decreases piglet weaning weight (Tokach et al., 2019; Thongkhuy et al., 2020). In previous studies, researchers have attempted to solve this problem in lactating sows in tropical environments by using various feed supplements to increase feed intake, milk yield in lactating sows and the growth rate of piglets (Silva et al., 2018). Moreover, in hyperprolific sows, higher dietary protein levels during lactation increases average daily gain of the litter, and this increase is associated with increased milk yield and increased daily protein output in milk (Strathe et al., 2017). These findings indicate the importance of daily feed intake during lactation in sows on the milk yield and litter performance. In tropical environments, poor feed intake of lactating sows is the main problem underlying poor milk production and inferior litter performance. In the poultry industry, supplementing the diet of broiler chickens with cinnamon oil results in a significant drop in heat shock protein levels and can reduce heat stress (Abd El-Hack et al, 2020). Moreover, aromatic plants and essential oils have been used successfully to stimulate the digestive system in poultry (Ertas et al., 2005). Cinnamon essential oils, including cinnamaldehyde and eugenol, have antibacterial activity against Salmonella spp., Escherichia coli and Staphylococcus aureus (Chang et al., 2001). In addition, an extract of cinnamon essential oils can disrupt growth of pathogenic bacteria while promoting growth of beneficial bacteria in the poultry digestive tract (Sarica et al., 2005; Kishawy et al., 2019). To our knowledge, no research has been conducted to investigate the effect of using cinnamon oil to improve lactation feed intake and milk production of sows as well as the growth of suckling piglets in a tropical climate. Therefore, the aim of the present study was to determine the effect of cinnamon oil supplementation in lactating sows on daily feed intake, milk production, pre-weaning piglet mortality, litter weight gain, growth rate of the suckling piglets.

Conclusions

In conclusion, our major finding is that cinnamon oil supplementation in the lactation diet for sows has beneficial effects on feed intake in lactating multiparous sows in tropical environments. However, increasing this amount of feed intake was insufficient to enhance milk production, milk quality, growth rate and serum IGF-I in the piglets. Some other factors associated with feed intake of lactating sows, for example, parity number, heat stress and postpartum illness, should be further investigated.

Producing Nutrient Cycle-Specific Effective Microorganisms (EM) for the Khao Hin Son Royal Development Study Center

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Introduction

Plant growth rate depends on the nutrient cycle, which is powered by different types of soil microorganisms. When plants shed their leaves or decompose, nutrients are released back to the earth. If the nutrient cycle is maintained, the soil will remain fertile enough for plants to grow and thrive.

Modern agricultural production focuses on sustainability and avoids use of synthetic chemicals. The emphasis is shifting from chemical fertilizers towards use of natural microbials, especially those with the ability to increase availability of plant nutrients to stimulate plant growth and productivity (Kuhad, 2012). This *'green'* approach has been recognized and aligned with sustainability targets under the United Nations Sustainable Development Goals (Costenza et al., 2016) and the Food and Agriculture Organization (FAO) (FAO, 2016). The approach is also consistent with the New Theory of Agriculture, a Royal Initiative devised by His Majesty the late King Bhumibol Adulyadej (Office of the Civil Service Commission, 2012).

These microbial groups enhance the overall benefits of plant nutrients, including increasing usable nitrogen, available phosphate and potassium, unlocking release of nutrients and other plant growth regulators, and increasing soil organic matter.

A class of microbials known as *'Effective Microorganisms'* (EM) has found increasing usage to enhance the plant nutrient cycle. EM has positive effects compared with synthetic fertilizers, and are safe to both users and consumers. EM contribute to stability and sustainability of the agricultural production system including the soil and environment as well as reducing dependency on external agencies.

EM are available in liquid or granular form, and have today moved from artisanal backyard production to commercially formulated products. However, these EM products typically provide little or no details on quality such as the types of effective microorganisms, place of origin, concentration, quantity, the abilities of the effective microorganisms, conditions or specific usage instructions. Exaggerated and sometimes unprovable claims are frequently seen on labels. Moreover, pricing does not reflect the actual production cost; such factors undermine confidence in this class of high-potential products.

Conclusion

Achieving production of EM for the Khao Hin Son Royal Development Study Center will improve farmer access to agricultural inputs in terms of biostimulants and soil ameliorants. The facility will also help reduce production costs and dependency on external inputs such as synthetic fertilizers, as well as promote sustainable production among local farmers. The development of EM products was achieved by improving the microorganisms that provide nutrients using proven culture methods. The microorganisms were enhanced and turned into a specific EM product that enhances nutrient cycle.

Sustainable Agricultural Development Research

Professor Alisa Vangnai, Ph.D., *Lecturer at Chulalongkorn University's Department of Biochemistry, Faculty of Science, who pioneered the use of microorganisms to remediate soils contaminated with chemical residues, shares her thoughts and experiences in research and development that can make a difference to the sustainability of farmland, agricultural development, and long-term conservation of our environment.*

Limitations of agricultural development in the pursuit of sustainability

"...the balance of land use and the use of agricultural resources constrains the transformation of agriculture toward sustainability, while ensuring efficient and resilient production..."

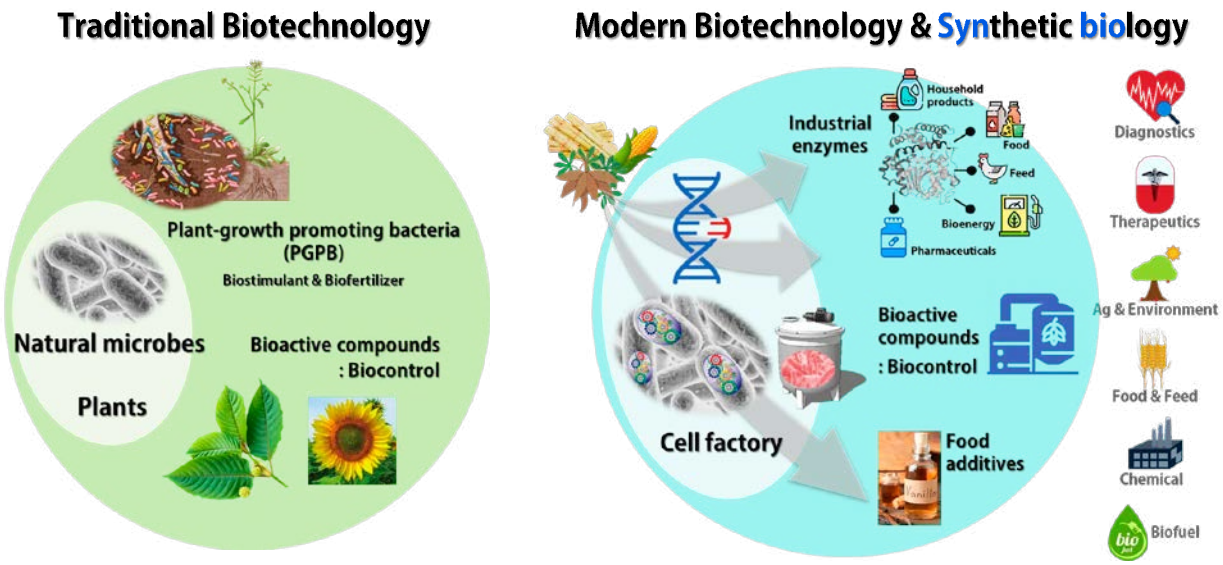
We all aware that sustainable agriculture requires a fine balance among three factors: production efficiency, cost effectiveness, and environment. The first challenge therefore is to strike this balance among these competing needs. Agriculture in Thailand, as in most other countries, is dominated by intensive, chemical-dependent farming systems. Excessive chemical use pollutes farmland and waterways, resulting in residues in food, the degradation of fragile ecosystems and biodiversity loss. The second challenge is to improve production efficiency to meet market demands and boost competitiveness. Various technologies are emerging to assist farmers in increasing farm efficiency and cost-effectiveness. With so much depending on the specific local context, more research is needed to better understand the processes and interactions that can drive a transformation of our agricultural land toward sustainability.

New frontiers in research into agricultural technologies

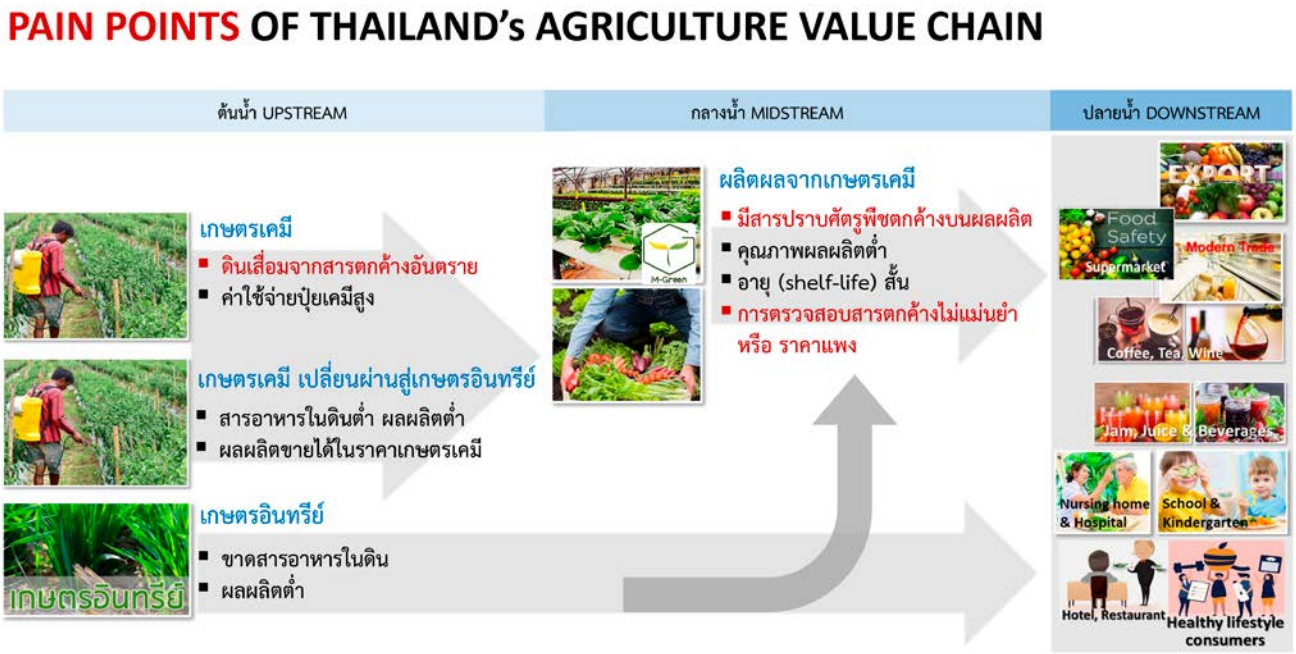
A raft of new technologies has emerged with the potential to radically change the way we produce our food. Robotics, drones, and Artificial Intelligence (AI) can be harnessed to conduct farm operations, inspect cultivation patterns, investigate outbreaks of insects, diseases or weeds, and much more. The era of Smart Farming has already begun, with Internet of Things (IoT) technology now capable of monitoring changes in cultivated areas, fertilizer and irrigation requirements, temperature and humidity. As a result, IoT monitoring will thus become increasingly important in ensuring optimal growing conditions and minimizing the use of scarce resources.

Biotechnology advancements have also resulted in new approaches to major challenges. Conventional biotechnology, for example, has been used to develop microbial formulae to remediate soils contaminated with chemical residues as well as to accelerate plant growth. Moreover, advanced biotechnology-based techniques can be used to scale up enzymes found in microorganisms for a variety of applications such as sanitizing fruits and vegetables to reduce chemical pesticide residues.

With the support from Faculty of Science, BIOM Co. Ltd. was found as a spin-off company to commercialize biotechnology research outputs. BIOM has been incubated under the National Science and Technology Development Agency (NSTDA), the Leaders in Innovation Fellowships program, the Newton Fund (UK), and the Chulalongkorn University Innovation Hub (CU Innovation Hub). BIOM is a biotechnology Research & Development company that not only develops its own technology platform and products, but BIOM also serves as an upstream research arm for a variety of industrial sectors including food, feed, agriculture, health, bioenergy, biochemicals and environment. The core technologies of the company are based on traditional biotechnology and synthetic biology (SynBio). Synthetic biology uses gene editing as well as bioinformatics and bioengineering techniques to create precise designs and is a powerful tool in the production of high-value chemicals such as enzymes and high value biochemicals for a variety of industries. Synthetic biology has the potential to make significant contributions to approaches such as Bioeconomy, Circular economy, and Green economy (Bio-Circular-Green Economy: BCG Economy). As Thailand is an agricultural country, the emphasis is initially placed on agricultural biotechnology research and development.



According to studies, the primary business weakness or pain point in Thailand's agricultural sector arises from its heavy reliance on intensive use of agrochemicals and chemical pesticides. These frequently chemical overuses are expensive and result in high level of chemical residues in food and the environment. Despite the efforts to implement a policy to encourage organic agriculture, organic methods can deplete soil nutrients if not properly maintained. In fact, biotechnology can aid in the improvement of soil fertility. According to the organic standard requirements, it is strictly specified a three-year transition period for cropland from conventional to certified organic status. During this transition period, the farmers' income is loss due to lower crop yield. Therefore, farmers must restore soil health and soil quality as soon as possible. BIOM has developed "Active soil microbial formula" by selecting a number of natural soil microorganisms, investigating their capability for pesticide degradation, and mixing in an appropriate proportion to use for restoration of soil health, reduction of pesticides residues in the soil and enhancement of soil fertility. In addition, the plant growth promoting bacteria are included in the formula. This "Active soil microbial formula" has already been tested in the fields with a variety of crops, including organic jasmine rice, tobacco and marigolds in Nan province, RD 57 rice fields in Suphan Buri province, Arabica coffee seedling cultivation in Chiang Rai province, cos lettuce in Nan province under the NIA Innovation Village program, and organic salad growing in Nonthaburi Province. In all cases, soil fertility, crop productivity and the farmer incomes were enhanced. From this accomplishment, new products based on the same concept and technology are developed for maize and Napier grass as high nutrient feed. This project is in collaboration with Faculty of Veterinary, Chulalongkorn University.



Pesticide use not only pollutes the soil, but also contaminates crop products such as fruits and vegetables. The harmful residues on food crops raise consumer concerns of food safety. The pesticide-detoxifying enzymes are currently being developed using a cutting-edge SynBio technology to remove pesticides from the surface of fruits and vegetables. The enzymes catalyze the dissociation reaction of pesticide molecules; therefore, detoxify them. This, in turn, increases the value of the farm produce and enables farmers to deliver it efficiently to the safe food market, meeting the needs of supply chain players such as wholesalers, supermarkets, exporters, and consumers (B2B and B2C).

The monitoring of pesticide residue remained on food crop or food is another pain point for agricultural market chain. The commercially available color-based test kit has insufficient sensitivity and low accuracy, while the laboratory testing is expensive and time-consuming, which often means that the result would not be ready in time for export. To address this gap, Associate Professor Kiattawee Choowongkomol, one of BIOM co-founders, has developed a biosensor using SynBio-based xeno-nucleic acid technology. This biosensor chip is developed based on the DNA-specific binding to pesticide and is designed as a small chip that can be plugged into mobile phone, inwhich the mobile application can analyze the test result to determine whether the fruits and vegetables are safe (Pass/Fail) from pesticides.

The biosensor test will also allow immediate inspection of food products by importers, exporters and supermarket distribution centers as well as health-concern consumers. It is expected that a prototype will be ready for validation by mid-2023. Other applications for biosensors are anticipated from upstream to downstream in food supply chains, and their use will certainly be expected to contribute to enhanced economic competitiveness.

Challenges in the development and application of agricultural biotechnology innovations to improve well-being and support national development

"...Many research studies remain on the shelf because they do not address real-world needs. Researchers must shift to consider potential applications as well as producing publishable research..."

Thailand faces significant cost challenges in the research and development of biotechnology-based innovations. Despite the country's efforts to fund research and product development, government budget allocations have been reduced for the time being, forcing researchers to seek funding elsewhere. Rather than focusing on real-world relevance in their research, researchers are encouraged to focus on producing peer-reviewed publications in order to meet the university's performance index and individual performance evaluation. As a result, even sound and well-researched research findings do not find application in industry and do not contribute to economic development or competitiveness.

Clearly, if researchers are to produce publishable research and research with commercial application, they must conduct due diligence on their proposed area of research. It is also necessary to be familiar with the relevant legislative and regulatory frameworks in Thailand as well as key international markets. Researchers, particularly in agriculture, need a better understanding of farmers' needs, their willingness to adopt new technologies, and their appetite for risk. Any of these factors can limit, if not completely prevent, the spread of technological innovation among resource-constrained farmers. Farmers cling to traditional methods not because they are naturally resistant to change, but because they have been "tried and tested." Farmers, like the rest of us, need a compelling reason to change that will not jeopardize their livelihoods or add to their debt. As a result, researchers must communicate more effectively with farmers, not only to impart knowledge of opportunities to adopt technological and market innovations, but also to understand how adoption may affect prices and access to markets for farmers who adopt new technologies, and how it may even marginalize those who are unable to access technologies, because technology is never neutral in its social and economic impacts. One critical factor is the cost of technology, which is frequently prohibitively expensive for farmers. As a result, researchers should consider the potential consequences of adoption from upstream producers to downstream market participants. Sustainability necessitates such a comprehensive view of the entire food value chain in order to achieve the previously mentioned balance. If implemented properly, such turnkey technological developments have the potential to improve the quality of life for both farmers and consumers.

Photo by Freepik.com

Thailand's agricultural development is curving towards a more sustainable future.

"...Not only does the country need to develop advanced technology on its own to deliver innovative goods and services, but it also needs to train, educate, and empower its citizens in order to boost national competitiveness...."

Thailand's desire to transform its agricultural sector into a more sustainable future will necessitate domestic development of advanced, low-cost technologies that are not reliant on imported know-how or technology. This independence will allow the country to not only develop and deliver innovative goods and services, but also train, educate, and empower its citizens, thereby increasing national competitiveness. Convergence of various technologies, such as IoT, AI, robotics, and satellite-based remote sensing, opens up enormous opportunities for more precise control of the physical environment. A large commercial greenhouse can be managed by a single person, who monitors and optimizes lighting and light intensity, temperature patterns, humidity, and CO2 levels on a continuous basis. This has the potential to increase productivity while decreasing labor requirements. These new capabilities have given rise to the concept of 'smart farming,' which is hoped will entice educated young people to join the next generation of farmers. Adoption of these technologies, including biotechnology, will eventually strengthen Thailand's agricultural sector and boost its global competitiveness.

The Role of Educational Institutions in the Development of Sustainable Agriculture

"...As academic researchers, we need to redouble our efforts to apply research findings in the real world, and to expose students to the real world. Only then can research become more targeted and more relevant...."

With university researchers contributing significantly to the body of knowledge on technology and innovation. The lack of adoption of such technologies has a real cost to the nation in terms of its budget and national development trajectory. As academic researchers, we must redouble our efforts to apply research findings in the real world, as well as to expose students to the real world in addition to the classroom and laboratory. Only then will research be more targeted and relevant.

Reduced public funding for research has forced researchers to seek funding from other sources, which is often on an annual basis. However, because many technological innovations can take years to develop, this provides an unstable foundation for research. Without guaranteed funding for the entire study, such research and development will be stifled, and work will be limited to short-term and surface-level issues. Of course, this is not conducive to the development of advanced technologies that can be protected and used to propel Thailand's agricultural sector toward sustainability.

Professor Alisa Vangnai, Ph.D., *graduated with a Bachelor's degree and a Master's degree of Science in Biotechnology from Chulalongkorn University and a Doctor of Philosophy (Ph.D.) in Biochemistry from Oregon State University, USA.. Professor Alisa Vangnai, Ph.D., specializes in biochemistry and molecular biology.*

"Around us"

Assoc. Prof. Thavivongse Sriburi, Ph.D.

Sustainable Agriculture: Importance and Necessity for Thailand

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Agriculture has historically been the mainstay of Thailand's culture as well as a major pillar of the national economy. In 2020, the share of agriculture in Thailand's gross domestic product was 8.64 percent, while accounting for over 25 percent of total export earnings. The sector still accounts for as much as 46 percent of total employment.

Despite agriculture's important role, farmers remain poor and labour productivity remains relatively low due to small farm size and lack of adoption of modern technologies and market models that might drive value-added at farm level and create economies of scale.

The lack of the necessary knowledge and resources to invest in improving productivity, particularly in rice production, represents a serious barrier to change.

Thailand is a major global food producer and has set its ambition as the *"Kitchen of the World"*. Over the past decade the government has been developing policies to modernize the sector while preserving the environment and natural resources. Agencies responsible for agricultural development have been established and staff allocated to assist farmers in all areas of the country. The Bank for Agriculture & Agricultural Cooperatives (BAAC) was established, dedicated to providing financial support services to meet the needs of small farmers. Still, it is evident that farmers overwhelmingly continue to operate in their traditional ways, with little change or development in their farming practices. Despite the large number of agricultural education institutions at various levels throughout the country, the younger generation is rejecting farming as a vocation. New graduates from agricultural academies seek non-farm careers rather than apply their knowledge on their family farms or to develop approaches to modernize the sector.

Almost all governments have made significant efforts to boost agriculture by introducing new technologies and teaching farmers on how to use them, yet have met with limited success. Only rich farmers with large land holdings and access to capital are able to reap the benefits of new technologies. Unfortunately, this group, representing just a small fraction of Thailand's farmers, are able to leverage a competitive advantage that results in further marginalization of small farmers who cannot compete, widening the equity gap.

Many traditional farming practices can harm the environment, including loss of natural resources, soil erosion, contamination by chemicals in both soil and water, damage to ecosystem balance and air pollution. Increasing awareness of the environmental impacts of agriculture led to the emerging concept of sustainable agriculture as a long-term solution. The aim is to shift farm practices by raising awareness among farmers of the importance of maintaining a balanced ecosystem on their fields, minimize the environmental effects of farming, while also generating higher incomes through increased productivity. Therefore, the government has established a sustainable agricultural policy as a long-term solution.

Over the past several decades, academics and organizations have coined numerous definitions of the term *'Sustainable Agriculture'*. The Office of the National Economic and Social Development Board has compiled the most well-recognized definitions as follows:

> *'The ability of agricultural systems to maintain production rates at a level that does not cause persistent and long-term damage under harsh or inappropriate environmental conditions which may occur regularly until they become a local feature, such as acidic soil or saline soil, soil areas that are flooded every year, or happen occasionally, such as flash floods, drought, pest, and outbreaks.'*
>
> *'An agricultural system that is related to, and complementary to, the natural resource and environment conditions of each ecosystem, and able to produce sufficiently safe produce for sustenance as well as a diverse range of yields.'*
>
> *'An agricultural system that encompasses agricultural livelihoods, production processes, and all forms of management to achieve economic, social, environmental, and ecological balance, which leads to self-sufficiency and improvement of the quality of life of farmers and consumers.'*

The United Nations has defined sustainable agriculture as

> *'...a farming system that deals with the integration and connection between soil, cultivation, and animal husbandry, as well as the elimination or reduction of the use of external resources that may harm the environment and/or the health of farmers and consumers, while emphasizing the use of techniques that are adapted to be part of the local natural processes of a specific area.'*
>
> *The three fundamental pillars of sustainable agriculture are described below.*

- **Economic sustainability:** Soil management and crop rotation should be encouraged to increase productivity and minimize dependence on machinery and chemicals, including fertilizers and pesticides.
- **Environmental sustainability:** Natural resources should be protected by using alternatives, recycling natural resources when possible, such as land (soil), water, and wildlife, and avoid using chemicals that are harmful to the environment, soil structure, and biodiversity.
- **Social sustainability:** Available labor should be used as much as possible or at least in some technical agriculture to foster fairness and harmony in society.

Photo by landactionthai.org

In Thailand, the concept of alternative agriculture or sustainable agriculture has been debated and practiced in various forms for nearly 30 years. It started with the first association of the public sector at the end of 1977, with participation from the public as well as government agencies and civil society advocacy groups. The definition of sustainable agriculture was concluded in the first Alternative Agriculture Assembly in 1992. According to the Assembly's resolution, alternative agriculture was defined as follows:

> *'The agricultural way that restores natural resources and maintain the balance in the ecosystem, can produce quality food sufficiently for a good quality of life of farmers and consumers, foster economically self-dependence, and enable farmers and local communities to freely develop themselves for the happiness and survival of mankind.'*

However, government and industry support for farmers remained narrowly focused on providing fertilizer and pesticide subsidies and at promoting exports. Agricultural policy did not consider the basic needs of farmers and local communities which are supposed to be at the heart of agricultural and rural development. Therefore, in the third Alternative Agriculture assembly held in 2003, the definition was revised to emphasize food sufficiency of families and communities and elaborated for clearer definition of best agricultural practices that contribute to sustainability. Ten basic principles or guidelines for sustainable agriculture were identified as listed below.

1) Apply and develop local wisdom in the agriculture system
2) Encourage farmers to play a key role in developing the knowledge and research in agriculture
3) Use local resources (land/system) and minimize dependence on external agricultural inputs (land/system)
4) Avoid using agricultural chemicals and fossil fuel products
5) Prioritize soil nourishment for sustainability
6) Take advantage of biodiversity, enhance diversity of farming activities in the plot, and maximize the synergy of production activities
7) Use natural approaches to control pest and avoid using chemicals
8) Treat nature and other organisms with respect
9) Produce nutritious quality food with complete nutrients in quantities that are sufficient to meet the needs to sustain life by responding primarily to food needs and lifestyle factors within families and communities
10) Facilitate farmers and communities to improve themselves without domination of a third party

In addition, at the Assembly meeting, five approaches to sustainable agriculture were proposed for farmers to consider using on their own farms:

1) Integrated farming that focuses on two or more production activities at the same time which support each other to create more added value by making the most of the limited land resources in the farmland.
2) Organic farming which focuses on production that does not use synthetic fertilizers or pesticides, but instead use natural alternatives to manage field pests, including neem extract, citronella, or biological extracts, and manures and composting to maintain a healthy soil.
3) Natural farming that focuses on agriculture that does not interfere with nature or as little disturbance as possible with no tilling, non-use of chemicals, independence on chemical fertilizers, and no weeding while mulching and green manure can be used.
4) 'New Theory' agriculture as advocated by HM the late King Bhumibol Adulyadej, that focuses on management of sufficient water resources in the fields to produce food crops, especially rice for household consumption where plants and livestock are produced for family consumption, with the marketable surplus sold to local markets to generate income.
5) Agroforestry is a style of farming with a focus on combining trees with short-term cash crops and animal production. This approach makes optimal use of light, soil and water resources and can boost total land productivity as well as enhance ecological diversity on the farm, as compared with monocropping.

In order for farmers to implement sustainable agriculture, they need accurate knowledge about best practices, to enable them to make informed decisions on shifting to practices that are optimal to their local farm, crops and climate conditions. On the other hand, government officials should function to provide technical guidance to farmers. More importantly, government agencies need to give greater support to marketing of local produce, as well as determining suitable integrated crops and livestock production systems based on the suitability and potential of the area so that farmers can be confident in shifting from their familiar traditional farming methods towards a sustainable farming system.

In the Thai context, a sustainable farming system should enable farmers to live with a high standard of living and employ agricultural technologies in collaboration with government authorities who can mentor and assist farmers at any time. Simple manpower is used as the main labor to minimize the cost and natural resources. For example, land should be used and disturbed as little as possible while optimizing production efficiency in small plots or small farmers.

Photo by pixabay.com

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Development of the Assessment System of Thailand Water Security

Photo by onwr.go.th

The Office of National Water Resources (ONWR)
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Water security is essential to national growth and development. It is therefore vital to monitor the productivity and cost-efficiency of water used, and boost the added value that it generates. Rivers, canals, and other natural sources of water should be conserved and rehabilitated to rebalance and restore our ecosystems. Thailand's Master Plan under the National Development Strategy Item 19 *"Comprehensive Water Management"* (Level 2 Plan) aims to achieve sustainable water management and sanitation for all, contributing to the UN Sustainable Development Goal No 6.

Its implementation requires development of proxies and indicators and an effective monitoring and evaluation system. An overall assessment of the status of the country's water security is essential as to identify gaps and hotspots, and to establish a baseline against which future progress and impact of implementation of the Master Plan can be measured. The overall assessment will identify urgent issues requiring immediate action and will help set ambitious but realistic goals for national development.

The Office of National Water Resources (ONWR) is mandated to lead implementation of the Master Plan under the National Development Strategy Item 19 *"Comprehensive Water Management"* (Level 2 Plan). In order to identify indicators and referenceable data appropriate to the specific context of Thailand, ONWR has partnered with **Chula Unisearch** to conduct a study titled ***"Development of the Assessment System of Thailand Water Security".*** The scope of the study covers three main areas as outlined below.

1) Development of indicators
   - Study and analyze available empirical data relating to water security for consumption in urban areas. The scope includes considerations such as economic development, environment, water consumption intensity, water productivity, indicators of disaster rehabilitation according to international standards, SDG 6 indicators, as well as indicators under the Master Plan for 20-year water resources management currently in implementation.
   - Study and analyze the Action Plan/project, key success indicators for each level, and data storage systems of relevant agencies to convert sub-indicators and establish a baseline.
   - Determine sub-variables and datasets for each identified parameter, evaluate the outcome to set a baseline for each indicator, identify barriers to progress and recommend actions and policies to enhance effectiveness of implementation.
   - Prepare an overview of the status of water security development in the wider social, economic and environmental context.
   - Collect, develop, and evaluate the indicators at provincial and river basin/catchment levels.
   - Prepare a manual for evaluating and storing water security indicators linked with the Master Plan for National Water Management and national strategy for use by operational staff within responsible line agencies.
2) *Development of the data link and processing system*
3) The data link system will be developed to link with economic and social datasets held by various responsible agencies, covering a range of key indicators including rural and urban water consumption, economic and environmental development, water consumption intensity, water productivity, indicators of disaster rehabilitation from, SDG6 indicators and development of water monitoring and processing operations. The outcomes are to be presented as visualized data showing multidimensional data at province and basin levels, as well as an aggregate macro-level country perspective for general use.
4) *Public consultation meeting and public relation media of the Project:* A series of consultations will be organized among approximately 100 representatives of relevant agencies to explain the approach, methodology, design, and evaluation of the indicators relevant to water security of Thailand according to the criteria of the Asian Development Bank and Office of the National Economic and Social Development Council. The consultation will be organized via three separate meetings with at least 30 attendees each from specific agencies or working teams. Subsequently, the study results will be presented to authorities and stakeholders with at least 100 attendees expected to join. Staff will be trained in use of the system, as well as public communications of the project and its benefits, as well as the use of visual media collaterals and system administration.

The findings of this study will provide a set of key indicators and baseline evaluation results, as well as an operational monitoring and evaluation system using modern presentation styles and visualizations. This system will be linked with the Master Plan for Water Resources Management to ensure cohesion and alignment. A manual will also be produced as a guideline to use the system for monitoring and evaluation of implementation of the 20-year Master Plan for Water Resources Management (Level 3 Plan), the Level 2 Plan regarding water and the UN Sustainable Development Goal No 6) as well as other relevant Sustainable Development Goals (SDGs). Finally, a manual for monitoring and evaluating national water security will also be published under the project.

Activities news

Seminar "Project Study of the Thailand-Hong Kong Free Trade Agreement"

On 10 June 2021 the Department of International Trade Negotiations, in collaboration with **Chula Unisearch,** hosted an online seminar on the ***"Project Study of the Thailand-Hong Kong Free Trade Agreement".*** The event was held to present the findings of the project study, authored by Assoc. Prof. Chackrit Duangphastra, Ph.D., Lecturer at the Faculty of Commerce and Accountancy, Chulalongkorn University. The seminar included a discussion on prospects for the Hong Kong economy, covering the following topics:

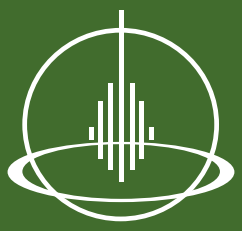
- Hong Kong's potential as a major investor in Thailand
- Opportunities for trade, investment, and collaboration with Hong Kong
- Opportunities and challenges for Thai and Hong Kong business sectors in the face of global trade uncertainty
- Thailand's potential to contribute to Hong Kong's food security
- Connecting Thailand's and Hong Kong's gem and jewelry supply chains as a gateway to global trade
- Learning from Hong Kong's logistics expertise to developing Thailand as a hub for ASEAN in a 'new normal' era

Video clip: 'Young Architect Eco Home Contest'

A short video has been created by the Power Development Fund under the Office of the Energy Regulatory Commission in collaboration with **Chula Unisearch** to publicize the Young Architect Eco Home Contest. The purpose of this is to educate and publicize the work, which is a standard construction model that emphasizes the importance of obtaining readily available clean energy to improve quality of life; the goal is to identify readily-built low-cost designs to build energy-saving homes. Visit www.youngarchecohome.com to see this informative video clip.

Discussion: "Will there be a great flood in 2021? How should we prepare?"

On 16 September 2021 the National Research Council of Thailand (NRCT), Office of Higher Education, Science, Research and Innovation joined with **Chula Unisearch** for a discussion on the topic: ***'Will there be a great flood in 2021? How should we prepare?'.*** The event was held at NSTDA (Yothi), with speakers from the Office of Higher Education, Science, Research and Innovation participating remotely via Zoom. Special Prof. Anek Laothamatas, Ph.D., Minister of Higher, Education, Science, Research, and Innovation, delivered opening remarks on the topic, ***'MHESI prepares to cope with the water situation with research and innovation'.*** The following panel discussion comprised experts including Bhichit Rattakul, Ph.D., Assoc. Prof. Seree Supratid, Ph.D., Sutat Weesakul, Ph.D., Chalump Oonariya, Ph.D., Thanet Somboon, Ph.D., Assist. Prof. Pongsak Suttinon, Ph.D., and Assoc. Prof. Sucharit Koontanakulvong, Ph.D. The panelists offered important academic perspectives on current and future trends in Thailand's water situation, as well as the risk of flooding and drought. The event was important as part of a collective effort to raise awareness and understanding among relevant agencies, local communities and the public in order to prepare for emergencies.



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