สวทช NSTDA

CREATING A SUSTAINABLE FUTURE FOR THAI FARMING SECTOR AND LOCAL COMMUNITIES WITH STI

CONTENTS

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FOREWORD

The National Science and Technology Development Agency (NSTDA) was established with an important task to accelerate science, technology and innovation development in Thailand in order to respond to the need of the industry and enhance the country's competitiveness in the global economy, and as a result, making contribution to national economic and social development. Since its inception in 1991, the agency has always balanced its research and development to ensure that its technology and innovation benefit both industrial and agricultural sectors.

Agriculture is considered a backbone of the Thai economy. It forms the foundation for several industries, including agroindustry, food industry and energy. Almost half of Thai labor force works in agricultural sector. Over the years, NSTDA has developed numerous technologies and solutions for agricultural sector and local communities, through its four national research centers specializing in four core technologies – ICT, biotechnology, materials science and nanotechnology – as well as through collaboration with researchers from other Thai government agencies and academic institutes. These technologies have been introduced to Thai farming sector by way of collaboration with local authorities and communities.

In an attempt to consolidate our expertise in delivering innovation to the farming sector, NSTDA established the Agricultural Technology and Innovation Management Institute (AGRITEC) in 2015 to serve as a bridge between innovators and farmers to ensure smooth technology adoption. With over 30 technologies in its portfolio – ranging from new crop cultivars, to farming equipment, technologies for soil, water and pest management, post-harvest and processing technologies, AGRITEC works in close collaboration with other government and non-government agencies to introduce appropriate technologies to our farming communities. To date, AGRITEC has worked with over 700 communities in 60 plus provinces throughout Thailand.

This publication illustrates our work in introducing technologies, innovations along with assistance in a number of areas - such as market access, quality standards and business development – with the ultimate goal of enhancing capacity and competitiveness of our farmers, villagers and social enterprises. It is our belief that enhanced capacity of our farming sector and people in the rural communities will become a robust engine to meet Sustainable Development Goals and support the Government's Bio – Circular – Green (BCG) economic model.

We would like to take this opportunity to thank our collaborators and people in the communities who have contributed to our endeavor to strengthen our farming communities with research and innovation. As our effort continues, we would like to welcome collaboration from both public and private sectors locally and internationally to join us in the pursuit of sustainability.

Dr. Narong Sirilertworakul
NSTDA President

HOMCHOLASIT: A PROMISING RICE CULTIVAR FOR A FLOOD-PRONE AREA

With 300,000 rai (48,000 ha) of land devoted to rice plantation, Phatthalung is a major rice producing province of southern Thailand. However, the long rainy season which can last for 8 months – typical weather of southern Thailand – does not make it easy for rice cultivation.

In 2014, flash flood-tolerant Homcholasit rice was introduced to farmers in Chai Buri Sub-district of Phatthalung through the distribution of seed by Chai Phattana Foundation. Two farmers, Sommart Maneerat and Thawee Butsaraphon, were responsible for seed production. Each allocated a 5-rai (0.8 ha) plot to produce Homcholasit seed in 2017 for distributing to members of Ban Kok Ching Community Enterprise – a community enterprise established by farmers planting Homcholasit in Ban Kok Ching Village in Chai Buri. The enterprise, headed by Preecha Onrak, has 21 members. “Most of our members grow Homcholasit for household consumption,” Preecha explains Homcholasit cultivation practice in his community. “Farmers who produce extra will sell their surplus. There is some growing interest among farmers in seed production.” The enterprise purchases Homcholasit paddy from its members at the price of 8,000 baht/ton. After the milling, the rice is sold at 30 baht/kg for a normal packaging or 50 baht/kg in a vacuum packaging. Fresh seed is purchased at 10 baht/kg and sold at 18 baht/kg. Profit from selling Homcholasit grain and seed is paid back to members in the form of dividend.

Prior to Homcholasit, members of the enterprise grew assorted varieties, including Phitsanulok, Chainat, Hom Pathum, as well as indigenous varieties like Lebnok and Sangyod. After tasting Homcholasit, farmers knew that they have a winner because of the distinct softness and fragrance that other varieties pale in comparison. Homcholasit has gained popularity among consumers in this area and the vicinity. Seed has been purchased by farmers in the nearby province of Songkhla. In addition to flash-flood tolerance, Homcholasit is resistant to insect pest, as it was able to survive the insect outbreak whereas other varieties could not.

In the first year (2017/2018), members grew Homcholasit along with other varieties. However, in 2018/2019 cropping season, all 130-rai (20.8 ha) rice field owned by the enterprise members grow only Homcholasit. This flood-tolerant variety is also cultivated on the 100-rai (16 ha) land in the nearby village.

Sopa Mukkata, one of the enterprise members, attests that cultivation of Homcholasit does not need special attention compared to any other varieties but the result is far more rewarding. “The variety recovers well after 20-day flood, provides the yield of 800 kg/rai (5 tons/ha) and commands higher price.”

Thawee produces Homcholasit seed twice a year, from January to April and from May to August. Her seed has 98% germination rate, according to the quality testing administered by Phatthalung Rice Seed Center. “Seed quality and farm management are two key factors determining crop productivity,” Thawee, an experienced seed farmer, underlines the importance of high quality seed.

Though it has been only 2 years since they started planting Homcholasit, farmers in this village are satisfied with the result and will continue to grow Homcholasit with support of new knowledge and technologies supplied by NSTDA.

Developed by research team of NSTDA, Kasetsart University and the Rice Department, Homcholasit, a cross between KDML105 and IR57514, was developed with a quality for flash flooding tolerance and non-photoperiod sensitivity using marker-assisted selection technique. It can survive under the water for 2-3 weeks after the occurrence of flash flood. Homcholasit can be planted for grains during and outside the regular cropping season, providing yield of 800 kg/rai (5 tons/ha).

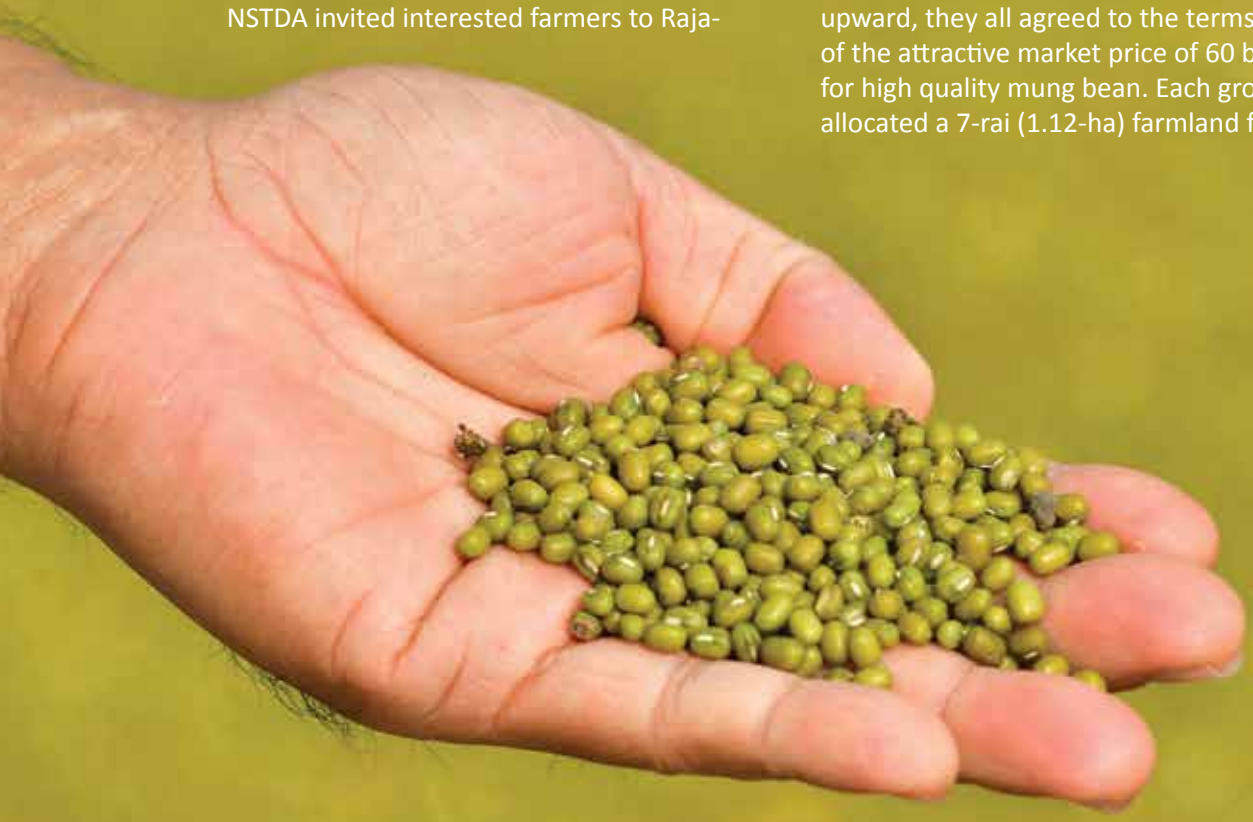
NEW CULTIVARS MAKE MUNG BEAN A CASH CROP

"Mung bean and soybean were never main crops in this area. People grew them in their back yard just for the purpose of kitchen ingredients," Padid Kamenketkit, Head of Ban Don Hwai Village, recounts the farming practice in his village in Uthai Thani Province.

However, things took a turn 15 years ago, when a ban on off-season rice cultivation was issued and mung bean cultivation was promoted to supplement farmers' income. Farmers can sell their produce to Chai Nat Field Crops Research Center or supply to the industry through middlemen. As a post-rice crop, mung bean is planted from November to February. However, maize farmers start planting mung bean in May. Chai Nat 84-1, Kampaengsaen 1 and Kampaengsaen 2 were among popular cultivars.

In 2016, the shortage of Kampaengsaen seed prompted Padid to look for other options. Upon consulting with the local agricultural extension office, he was introduced to newly-released mung bean cultivars, KUML1 to KUML5. To promote these new cultivars, NSTDA invited interested farmers to Rajamangala University of Technology Lanna Lampang to gain more information on the cultivars at the demonstration plot. Ten farmers from this village traveled to Lampang Province. After inspecting properties of plants and beans, they picked KUML3 for its light weight, KUML4 for its large bean size and KUML5 for its nice bean shape and distinct pod color making it easy to spot and remove contaminated plants in the field.

These ten farmers started forming a KUML mung bean grower group to work with NSTDA. They had to agree to the cultivation techniques prescribed by NSTDA which include manual seed dropping, manual harvesting and bean-size segregation before selling. Although these demanding techniques drove the production cost upward, they all agreed to the terms because of the attractive market price of 60 baht/kg for high quality mung bean. Each grower allocated a 7-rai (1.12-ha) farmland for mung



bean cultivation and received 2.8 kg/rai of seed of his/her choice (17.5 kg/ha) in the first year. Productivity of the first year was not satisfactory, but these growers did not feel discouraged as they understood that there would be a learning curve. Instead, they tried to learn and familiarize themselves with chosen cultivars. In the second year, each farmer increased the planting area to 10 rai (1.6 ha). Instead of giving out seed, NSTDA opted to lend seeds and buy back produce from growers at a guarantee price of 50 baht/kg. In this second year, farmers put more effort to tend their farms. Wasan Philuek, an experienced farmer of this group, volunteered himself to visit and inspect farms of other members and provide suggestions on pest management. It was told that many of his visits were unannounced! This time around, all their effort was paid off. The productivity of this second year exceeded 200 kg/rai (1.25 tons/ha).

Although NSTDA's buyback program only lasted for two years, this grower group continues to plant KUML cultivars, but has made adjustments to some cultivation techniques. Manual seed dropping and harvesting are now replaced by seed casting and machine harvesting in order to keep the production cost down. Produce is now sold to middlemen. With good performance, the group membership has grown to 15 farmers.

New members are carefully screened as the group wants to maintain their reputation as producers of premium quality mung bean. Each member has a planting area of 10 rai (1.6 ha) or more. Some own their land, while others plant mung bean on someone else's land for free in exchange for green manure the legume plants become after harvesting.

It is unfortunate that the flood has caused damage to all mung bean fields in 2018/2019 cropping season, except for one belonging to Wasan. Wasan - who has increased the planting area to 27 rai (4.32 ha), his own and some rental land - planted his mung bean earlier than his peers so the plants were big enough to survive the flood. Wasan decided to keep his KUML4 produce for members of his group to use as seed for the next cropping season. NSTDA also donated KUML seed to flood-affected farmers. As the industry demand for KUML mungbean grows due to its superb quality, this farmer group is keen to produce KUML seed to supply to mung bean farmers in other regions. With this aspiration, NSTDA provided training on postharvest management of seed and connected the group to mung bean farmers in other areas, thereby enhancing the whole mung bean production value chain.

Five mung bean cultivars, KUML1 to KUML5, were developed by Prof. Dr. Peerasak Srinives and Assist. Prof. Dr. Prakit Somta of Kasetsart University with research grant provided by NSTDA. These KUML cultivars are disease-resistant and have short maturity time, providing high yield of 200-300 kg/rai (1.25- 1.875 tons/ha).

RAISING CASSAVA PRODUCTIVITY THROUGH TECHNOLOGY

Along the dusty road in Wang Chaphlu Sub-district in Kamphaeng Phet Province are myriad cassava plantations on both sides. Cassava - well-known for needing very little input and attention – is a cash crop in this area.

Sripho Kayankannawee, Head of Moo 2 Village in this sub-district, participated in the NSTDA-DOA-LDL project to increase cassava productivity in 2014 after visiting the project's cassava plantation in Nakhon Ratchasima Province. He recalls that for years, farmers in his community grow cassava with little knowledge. They used cultivar that they heard was good, never measured fertilizer input, planted as many plants as possible, thinking that more plants would yield more roots, and never calculated the production cost. "Despite applying large amount of fertilizer, our yield never improved," Sripho laments.

Hoping to see improvement in their productivity, Sripho and over 100 cassava growers in Kamphaeng Phet decided to join the project. Each participant started off with a 5-rai (0.8 ha) plot. The very first things they had to adopt were plant spacing and fertilizer application based on soil analysis. Plant spacing had to be increased from 40-50 cm. to 80 cm. Soil samples were sent for analysis. The test showed low levels of nutrients, and therefore the project's expert team suggested an application of organic matter and proper amount of fertilizer.

The average yield of the first crop increased to 5 tons/rai (31.25 tons/ha). Sripho's plot – serving as a demonstration plot and installed with a drip irrigation system – achieved 6 tons/rai (37.5 toms/ha). Farmers' confidence was boosted by this outstanding

result. In the following cropping season, they applied these planting techniques to all of their farmland and had drip irrigation installed on their own. However, due to drought crisis, the productivity dropped to 2-3 tons/rai (12.5-18.75 tons/ha). “Farmers were devastated, and started to turn against the project,” Sripho remembers the dark period. Fearing that farmers would abandon this project and go back to the old planting practice, Sripho, the project’s expert team and owners of cassava starch factories in the area met with farmers and explained the effect of climate on crop productivity and the need for proper drip irrigation installation. This intervention brought back the members. Training on drip irrigation installation was provided. The yield in the following season bounced back. Some member even got as high as 7-8 tons/rai (43.75-50 tons/ha).

Sripho’s 31-rai (4.96 ha) cassava plot has proven to be an excellent demonstration and trial plot. His field has been used by many agencies for cassava variety tests and demonstrations of soil-test-based fertilizer application and farm equipment. Farmers learned from his field can achieve as high as 9 tons/rai yield (56.25 tons/ha).

Apart from planting techniques and input (soil, fertilizer, water) management, plant cultivar is also an important factor affecting productivity. Members are provided with recommended cultivars for each soil type. “To achieve high productivity, we choose high starch content cultivar and improve our yield through planting techniques and management,” Sripho reveals.

It has been five years since cassava growers in Kamphaeng Phet joined the NSTDA-DOA-LDL project to improve cassava production. Productivity under rainfed condition is 5 tons/rai (31.25 tons/ha) or more, whereas an irrigated field can yield up to 6-7 tons/rai (37.5-43.75 tons/ha). In addition to higher productivity, the benefit that they gain is the reduced production cost, especially fertilizer cost.

"We change the way we plant cassava and have to tend our farm more than we used to," Sripho adds. "But it can be done. There is no need to hire labors. Once we see the fruit of our effort, we want to work more and take better care of our field. It becomes our pride."

NSTDA, in collaboration with the Department of Agriculture (DOA) and the Land Development Department (LDL), implements a project aiming to improve cassava productivity by providing and demonstrating, to farmers, knowledge and technologies including soil analysis, soil-test-based fertilizer application, recommended cultivars for specific soil type, pest and disease management and the use of drip irrigation system. Four demonstration plots were established in Kanchanaburi and Kamphaeng Phet provinces. The project later expanded to Lampang, Kalasin and Ubon Ratchathani provinces.

SWITCHING TO ORGANIC FARMING FOR BETTER HEALTH AND INCOME

Anong Soncha is a member of Rak Si Thep Cooperative located in Si Thep District, Phetchabun Province. She turned her back on sugarcane monocropping – a family business that she knew of all her life – and started organic vegetable farming after witnessing the success of her daughter, Rotjana Soncha, and young generation of Rak Si Thep Cooperative supplying organic vegetable to the expanding market.

Soil deterioration, prevalence of chemical pesticide and price fluctuation of sugarcane monocropping are among concerns of young generation who returned to the countryside to take up their family's farming business. So they decided on organic vegetable farming.

"We want to grow food that is safe for our own consumption, as simple as that," Natthawan Thongkled, a former banker, discusses the motivation to start organic farming. "Now the older generation also joins our initiative. They stop using chemicals, as we have access to a good and stable market for our organic produce," Rotjana adds.

Finding market, as it turned out, was as difficult as cutting back chemical usage, but Rak Si Thep Group never stopped looking for new markets for their products. Through the help of the local administrative office, Rak Si Thep Group was introduced to the modern trade sector, opening up their new market which led to the establishment of Rak Si Thep Cooperative in mid-2017 with approximately 100 members, 10 of which are organic farmers. "Modern trade is a high-quality market and offers a good price," Rotjana says.

At first, the cooperative did not have its own packaging facility. They had to transport their produce to the nearby packaging facility located 170 km away. "It eroded our profit, but it had to be done in order to gain access to this promising new market," Rojjana explains. Their early products include waxy corns, eggplants and banana supplying to

Tops Supermarket, a supermarket chain owned by Central Group.

Nowadays, the cooperative has a cultivated area of 200 rai (32 ha) that meets GAP codes - growing cherry tomatoes, waxy corns, sweet corns, chili, okra, and etc. - and its own packaging facility. Despite having an established outlet for their produce, the cooperative continues to upgrade their knowledge and technology to improve their production. Through the training organized by NSTDA, these growers were able to learn proper cultivation techniques, enabling the improvement in quality and productivity. With the training on tomato cultivation provided by Prof. Dr. Suchila Techawongstien of Khon Kaen University, Anong is able to increase the seed-usage efficiency by 66%, whereas the training on corn cultivation by Asst. Prof. Bhalang Suriharn of Khon Kaen University enables Sumalee Paekekatoke to triple her corn productivity. Apart from cultivation techniques, knowledge on other topics such as vermicomposting, new varieties of tomato and corn, and plastic-film greenhouse were introduced.

It has been two years since the establishment of the cooperative with reliable market and migration from chemical farming. These growers are satisfied with increased earnings and better health, and always welcome new knowledge and innovations to improve their products.

AGRITEC-NSTDA and Central Group established a program to enhance the capacity of farmers in Phetchabun Province who supply farm produce to Central Group to meet acceptable standards. Participating in the program are farmers of Rak Si Thep Cooperative in Si Thep District, Nam Duk Tai Vegetable Production Cooperative in Lom Sak District and Nam Nao Agriculture Cooperative in Nam Nao District. The program also includes vocational training for villagers in Ban Na Sa-ngung Village in Lom Kao District who are faced with farmland limitation.

WEATHER STATION: ENABLING INSTRUMENT FOR PRECISION FARMING

Dew covering grass lawn means high humidity. If you see a dragon flying low, brace for heavy rain. Fruit growers have long been using these nature observations in combination with weather forecast provided by the government agency to manage their farming activities. But these may not be sufficient for next generation farmers.

Doungporn Wetchasit, Thammarat Chandee, Kittipat Sriram and Natarada Phisantanakul are members of Young Smart Farmer Group in Chanthaburi Province. Young Smart Farmer Group recognized the power of technology in improving efficiency of their fruit orchards. They started using "weather station" in 2018.

"Our parents' generation made observation on the weather and learned to manage their orchard based on their accumulated knowledge and experience," says Thammarat, a former office worker who now runs a 14-rai (2.24 ha) orchard. "Now that we have the weather data, we can match what our previous generation observes and actions taken to the scientific data that we have. We then have a clearer understanding and can manage our orchards with precision."

The crucial stage of fruit orchard is flowering which is highly influenced by water input, so precise information on the weather and accurate weather forecast are essential. "If a mistake is made with flowering induction, one has to wait for 2-3 weeks to redo the process, which is not time efficient," Doungporn, Vice President of Mango Orchard Group in Khao Khitchakut, says. Kittipat adds

that young smart farmers want to manage their orchard with scientific principles and understanding, rather than guessing.

Weather station is equipped with sensors for measuring temperature, soil moisture, relative humidity and light intensity, as well as an anemometer and a rain gauge. These sensors and instruments provide real-time data which are recorded to the weather station system. It is these data that these young smart farmers use in making operational decision on orchard management.

“Based on the weather station data, we decided to irrigate our orchard for 2 hours in November,” Doungporn recounts her experience using data from the weather station to schedule the irrigation of her mangosteen orchard the previous year. Trusting the data, Doungporn was the first of the group to apply water. “The owner of our neighboring orchard disagreed with our assessment. She watered her orchard 2 weeks later, at the time that we did not think she should by looking at the weather data. As it turned out, we were right. While we were harvesting fruits in our orchard, the neighboring orchard just started flowering.”

Natarada's 100-rai (16 ha) orchard is located 300 m. above sea level, facing longer rainy period than other orchards in this area. Due to more rain, fruits in her orchard usually are ready later than others' and are more at risk of damage caused by rain. Weather data is therefore very vital for Natarada. "We wanted to make our orchard produce flowers and fruits at the same time as other orchards located at sea level. We compared the weather data at our orchard to those at sea level and developed our orchard management plan, i.e. identify time to irrigate, to prepare workers, gasoline for water pump, etc. These are costs that we have to manage."

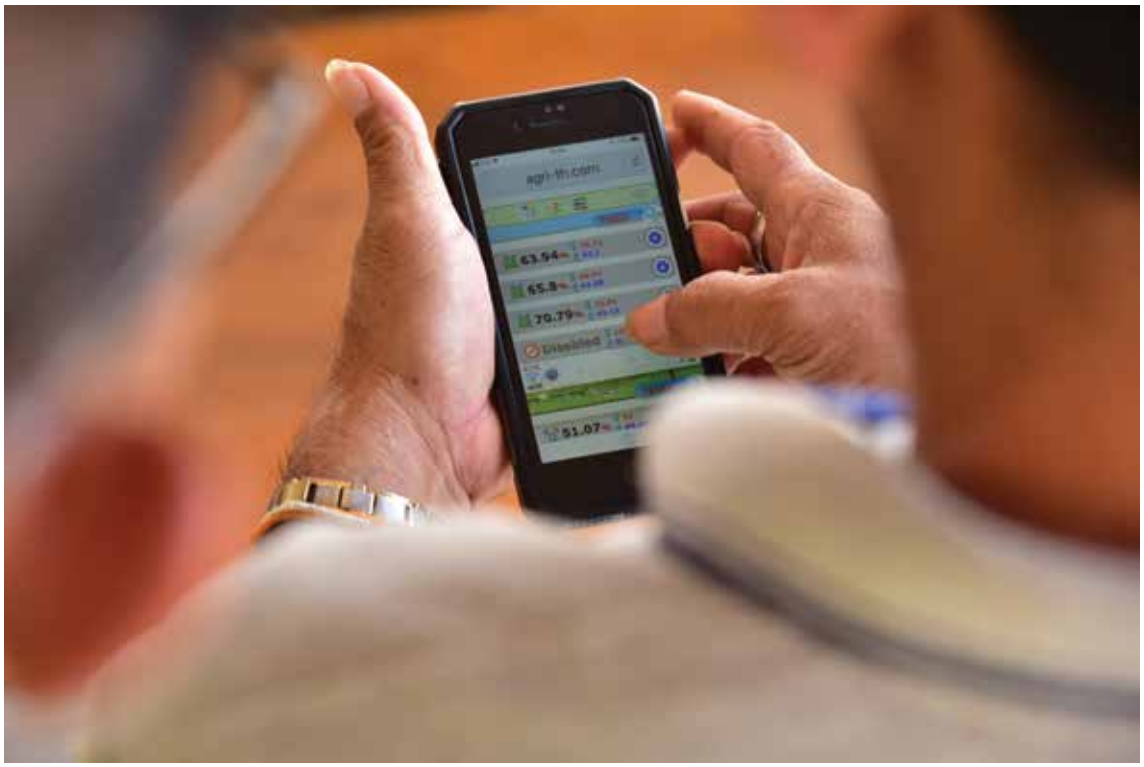
These days, these four orchard owners regularly check the weather data on their mobile phones, particularly Doungporn and Natarada who do not reside near their orchards. "Since I am not on site, I rely on the chart on my mobile phone to manage the orchard. If I were to ask my worker about the weather on site, his reply is only subjective," Doungporn says.

Although each of the four growers has a weather station installed at his/her orchard, they have access to weather data of each other's station, and even share their data with other growers in their group. They now have full confidence in the weather data. Thammarat uses the data to analyze the spread of insect pest and factors determining flowering. He can now control the flowering stage using the weather data. Kittipat added that the real-time data help identify immediate action to take, but historical data enable him to draw the correlation between the weather and the disease and insect outbreaks.

AGRITEC-NSTDA and NECTEC-NSTDA have installed the weather stations in 16 orchards and farms in Rayong, Chanthaburi, Buriram, Nakhon Phanom and Chiang Mai.

ORCHARD MANAGEMENT WITH SMART FARMING TECHNOLOGY

"Farmers should always be open to new knowledge and have curiosity," says Somboon Ngamsangiam, owner of Bua Kaew Durian Orchard and Vice President of Durian Quality Improvement Group of Ban Wang Chan Village, Wang Chan District, Rayong Province.



Somboon and his wife like to experiment and look for ways to improve the quality and price of their durians. They started the off-season durian production ten years ago - amidst advices against it from friends - to avoid low price driven by oversupply of durian during peak season. Somboon disproves them as he has been able to earn good income and his farmland has expanded from 24 rai (3.84 ha) to 70 rai (11.2 ha) over the ten-year period.

Despite the success in producing off-season durian, Somboon never stops experimenting. He agreed to collaborate with NSTDA by allocating his 2-rai (0.32 ha) land, with 30 durian trees, for a field experiment of "Smart Plant Watering Control and Weather Monitoring System".

Water and weather are two essential factors for durian cultivation. Water is required in all stages, especially during the flowering and fruit development. Durian growers use their observations on weather and trees in combination with their experience to manage their orchards. They are not aware that what they observe can be measured scientifically.

Smart Plant Watering Control and Weather Monitoring System consists of several sensors to make various measurements – soil

moisture content, humidity, light intensity and temperature - and a control of irrigation. These parameters are used for orchard management, especially the water input to meet the requirement of each growth stage, eliminating overwatering, saving labor cost and yielding better fruit quality.

In the first year, data on soil moisture content suitable for watering at various growth stages of durian tree were collected. During plant growth, the soil moisture content should not fall below 28%. Flowering tree does not need much water, so soil moisture should be between 28%-34%, whereas during the fruit development, soil moisture should stay between 32%-40%. These results were obtained by correlating his observation-based irrigation management with the data read by the system, i.e. translating his sense to number. “The data will be useful for orchard management in the future,” Somboon opines. Having used this system for over a year, Somboon is planning to have the system installed in his entire orchard over the next two years.

"I am obsessed with this system now. I look up the data on my mobile phone 3-4 times a day to check if there is any change on the moisture," he laughs while confessing his new habit. When he travels, he relies on these data to make decision on watering schedule. Even when he called his team and they reported that it just rained, he still ordered them to apply water because the soil moisture content showed in the system was still below the optimal level.

"This technology is very easy to use. The system enables precision farming, enhancing input efficiency in both energy and water," Somboon says. "Farmers do not have to go for a full-option system – sensors and irrigation control. They can choose to install only one or two sensors such as the measurement of soil moisture and can also opt out of irrigation control and choose to do manual watering."

After obtaining preliminary data for orchard management, Somboon is now collecting addition data with the new set of sensors. He shares the system dashboard displaying temperature, moisture and light intensity with 30 members of Durian Quality Improvement Group of Ban Wang Chan via a communication app every morning, so his peers can use them as a reference for their orchard management. His Bua Kaew Durian Orchard now welcomes visitors to learn about off-season duration production management and Smart Plant Watering Control and Weather Monitoring System.

AGRITEC-NSTDA promotes the use of smart farming technologies among farmers through the experimentation and demonstration with farmers on-site.

REPLACING CHEMICALS WITH MICROORGANISMS

A longan grower making six-figure earning a year, Ratthana Jundam, Head of Moo 4 Village in Chiang Mai Province, spent 7 years learning about sufficiency economy before making a big decision to turn away from monocropping to integrated farming.

"I was skeptical at first whether integrated farming would be viable. Harvesting vegetable daily to make a few hundred baht a day sounded so little, yet so much work, compared to what I earned from selling longan for several hundred thousand baht a year," Ratthana says. But as a village head, she had to attend series of training on this subject. After a while, it started to make sense to her and she decided to give it a try. It was hard at first, but the benefit is worthwhile, especially the health benefit attributed to chemical-free farming.

Longan orchard is known for intensive use of chemicals and because of this, growers in Ratthana's village are faced with health problems. It took Ratthana two years to transform her 7-rai (1.12 ha) longan orchard to an integrated farm. She also turns her farm into a learning center for sufficiency economy for her community. The farm consists of an organic vegetable plot, chicken coops, a fish pond and an orchard with several types of fruit trees. Ratthana was determined to reduce chemical usage in her community and actively sought knowledge and technology to solve this problem.

"I was given an opportunity to attend a workshop to learn about the agricultural application of microorganisms at Maejo University," Ratthana says. The lecturer at Maejo University has screened several types of microorganisms for a number of purposes. Microbes capable of breaking down organic matters are used for composting. Some microbes, called biocontrol agents, can be used for controlling plant pests and diseases. Some microbes can be used for eliminating foul odor.

She applies microorganisms obtained from Maejo University in her farm and experiences drastic improvement in her farm. Fruit trees and vegetables are free from diseases and insects, thanks to biocontrol agents that she uses in place of pesticide. She applies composting microbe on the ground of her fruit trees to help digest fallen leaves and fruits. Despite having two chicken coops on the property, there is no bad smell, because the coops are sprayed with odor-control microbes, instead of disinfectant. Her fish pond previously gave out foul odor, because of dead fish problem. Ratthana applies odor-control microbes to the pond weekly. Not only does the foul odor go away, she no longer has dead fish problem.

After successful results, Ratthana introduced these useful microbes to growers in her community. She propagates microorganisms obtained from Maejo University and gives out to members of her village for free. At the learning center, three types of microbes – biocontrol agents, composting microbes and odor-control microbes – are placed in labeled 200-L containers for her villagers to help themselves.

Villagers were interested to try these microbes because Ratthana has demonstrated their performance on her farm. And they work on others' farms too. With word of mouth, Ratthana's microbes are now used by growers from nearby villages.

"Unlike microbe powder I received from other agency, these microbes are easy to use and very effective," one villager shares his

experience using microbes obtained from the learning center.

Switching from chemicals to microorganisms may be troublesome in the beginning, but these farmers are keen to change as they recognize the benefit to their health and the ecosystem. In addition, production cost can be saved from eliminating chemical usage. Thirty farmers in Moo 4 Village are regular users of these microbes, and Ratthana continues to make microbes available for free.

NSTDA provided research fund to Asst. Prof. Tapana Cheunbarn, Faculty of Science, Maejo University to investigate the microbial applications in agriculture and the environment. The research result has been transferred to the community.

ENSILING CROP MATERIALS FOR FEED MAKES CATTLE BUSINESS MORE PROFITABLE

Every day before and after work, Suriya Tongsa makes a stop at Sunisa Farm - his beef cattle business that he hopes to live off after his retirement from the government position at Phayao Livestock Research and Breeding Center. Suriya chooses cattle farm business because cattle fetch good income. However, it is not without a caveat. Feed represents the largest production cost for cattle operations. Recognizing that plant materials are abundantly available in his area, Suriya was confident that he could keep the feed cost sufficiently low and thus make good profit from his cattle business.

In the beginning, Suriya's cattle were raised on pasture. He later shifted to feedlot cattle because of the high market demand for marbled meat and thus high price – 110 baht/kg as opposed to 80 baht/kg for pasture-raised beef cattle. Suriya searched information on feedlot cattle and found that in addition to breeds and farm management, feed is a vital factor to influence marbling.

"Feedlot cattle require a concentrate diet and high-starch feeds, on top of roughage," Suriya explains. "I fed them some cornhusk in various forms – fresh, fermented and mixed with molasses – and pumpkin." Both cornhusk and pumpkin were obtained at no cost, reinforcing Suriya's concept of keeping the feed cost as low as possible.

Suriya was introduced to the ensilage of crop materials by the research team at the University of Phayao. "Most of the time, I obtain crop materials in surplus and some will go bad," Suriya says. "By ensiling – placing plant materials and microorganisms in a container and allowing the digestion to take place, I can preserve these materials for longer use." The test performed by the University of Phayao showed that his silage has high protein content.

After a year of raising feedlot cattle supplementing with silage, he sold 4 animals for almost 400,000 baht, at the production cost of 200,000 baht. However, he was not able to obtain feed materials for free any longer as farmers knew that he could turn good profit from these residues. But Suriya is able to manage this setback by switching to less expensive alternatives for costly materials whenever he can. From the second year on, his production expenses become stable.

Feedlot cattle have an average feed cost of 80-90 baht/day/animal if commercial feed is used. But at Sunisa Farm, an average feed cost is around 45-50 baht/day/animal because seasonal crop materials are used. For example, banana is used instead when there is cassava shortage. With information on protein and energy content of each crop, Suriya is able to manage his feed - a mixture of feed that he gathers himself and supplemental commercial feed – accordingly to meet nutritional requirement of cattle at various stages.

Commercial feed contains known percentage of protein. “Overall, the mixed feed used in my farm has similar protein content to that of commercial feed,” Suriya says. Ensilage

helps improve protein content, nutrition and digestibility of crop materials. As a result, his cattle are graded high when sold to buyers.

To make silage, Suriya places plant materials – such as cornhusk, baby corn, sweet corn, pumpkin and banana (or cassava) – in a 150L drum, adds 10 grams of microbes and covers with a lid. The silage is ready after 7-10 days, or 15 days if fresh cassava is used in order to reduce the cyanide content in cassava. This silage is fed to cattle along with rice bran, oil palm meal and rice straw.

Suriya embraces the use of knowledge and technology in his farm. He admits of "having fun in trying out the technology and waiting to see the result." He makes observations on the cattle's eating habit and the grade of his cattle given by the buyers and uses this information to make improvement on the feed. He has shared his experience and knowledge on silage with his fellow cattle farmers in Phayao, Lampang and Sa Kaeo provinces, and even neighboring countries such as Laos.

NSTDA awarded a research grant to Dr. Khanchai Danmek of the University of Phayao to develop low-cost animal feed using crop residues. The result of this project has been transferred to a private company to produce a commercial inoculum for ensiling materials containing fiber and starch.

LATEX PILLOW: ADDING VALUE TO NATURAL RUBBER AND STRENGTHENING COMMUNITY BUSINESS

Struggling from falling rubber prices, Anan Chanrat, a rubber farmer in Phatthalung Province, proposed an ambitious idea of a rubber processing factory manufacturing natural latex foam pillow. The idea was warmly supported by his rubber-farming-based community, leading to an establishment of Banprakha Agricultural Cooperative in mid-2015 with 50 founding members. The production commenced on 12 January 2017.

Early on, the factory was faced with several problems. The cooperative had no bargaining power when purchasing latex concentrate and chemicals from suppliers, resulting in high production cost on raw materials. Workers lacked technical knowledge on the manufacturing process and were unfamiliar with equipment and machinery. They were not doing well on market access and investment capital either. Little by little, the problems were solved. Staff received proper training on how to operate each piece of equipment, learned to manage the production cost on electricity and labor, as well as finding market for their products. They even made the improvement in the quality standards of production process.

The production of latex foam pillow starts from processing the field latex collected from rubber trees into latex concentrate. The latex concentrate is then processed into latex foam and placed into a mold. After removed from the mold, the pillow is steamed, washed and dried.

The problematic step was the process that turns field latex into latex concentrate. Even with the right equipment, they were not able to produce good quality latex concentrate, due to the lack of knowledge. Despite attending training courses offered by many institutes, the staff was still unable to apply the knowledge to their settings. The cooperative therefore had to purchase latex concentrate from a supplier.

"The turning point of our factory was the meeting with research team from MTEC-NSTDA," says Anan who is now the cooperative manager. MTEC team provided the training to the staff on-site, making sure that the process worked with the machine and materials used at the factory. Finally, the cooperative was able to produce latex concentrate and control the quality. From that point on, the factory can take in field latex supplied by rubber farmers to the production. Banprakha Agricultural Cooperative became the first community-based business that can process field latex from rubber farmers into finished products.

But it did not stop there. MTEC and the cooperative continued to work together and successfully developed innovative latex concentrate that can reduce the production time and yield soft and pleasant-smelling pillow.

With determination of the cooperative and the technology supplied by NSTDA, Banprakha Agricultural Cooperative is able to cut down the production cost by 400,000-500,000 baht/month as they no longer have to purchase latex concentrate. In addition, they are able to set a fair latex price for rubber farmers. The initial goals of adding value to the natural rubber and helping rubber farmers have been achieved.

The product now has its own brand “Talung Latex” and is sold in convenient stores in gas stations, online and at trade shows. In addition to pillow, the cooperative also makes mattress and seat cushion. Sales revenue now reaches 1 million baht/month. The cooperative also does OEM production for exporters.

AGRITEC-NSTDA and the Bank for Agriculture and Agricultural Cooperatives co-sponsored the project transferring rubber processing technology to Banprakha Agricultural Cooperative to enhance the competitiveness and enable sustainability of community enterprise with science, technology and innovation.

PLANTING NEW CROP OF SEED FARMERS

"I want to build my own business. I give myself three years to do it by joining this program," Suwitree Daenkhanan said on the first-year anniversary of her participation in the "Training Program for New Seed Producers" – a 3-year program aiming to increase the number of seed farmers by providing necessary skills and mentorship in seed production to new graduates in agriculture to become seed farmers. Having completed the 3-year program, she is now on her path to become a successful seed producer.

Suwitree was recruited to take part in the training program after graduating from Faculty of Agricultural Production, Maejo University. As part of the program, she served an apprenticeship in Supreme Gold Seeds Company Limited for 6 months to learn techniques, skills and principles to prepare her to become a seed farmer. After the apprenticeship, participants return to their hometown to start their seed farming business under the mentorship of NSTDA and the seed company that they received the training. At the end of the 3-year program, NSTDA and seed companies that joined the program expect to see these young generation become successful seed producers and form a network of seed producers in his/her communities.

In her first year as a seed farmer, Suwitree rented a 2-rai (0.36 ha) land plot to grow 2,000 plants - bitter gourd and yardlong bean - for seeds to be supplied to Supreme Gold Seeds, the company that trained her. Her sister, Woranaree Daenkhanan, also a graduate in agriculture, left a full-time job to join her, hoping to build a business of their own. They were happy with the result, making 70,000 baht in their first year. After this success, they moved the production to an 8-rai (1.28 ha) plot owned by their family. Scaling up was a big challenge for the sisters.

"Although bitter gourd seed gets a better price, it requires more care and attention, which means we have to hire workers," Suwitree says. "So we decide to produce only yardlong bean seed, to fit with our capacity." She also scheduled her production period to avoid the pesticide application time in the sugarcane fields nearby.

Seed production brings substantial earnings, but it takes a long period to earn the money compared to vegetable farming. So Suwitree has to plan her production and manage her land use to optimize the cost in order to generate an income stream for the family. She allocates part of the land for organic vegetable farming - growing sponge gourd and cucumber - and the rest for seed production. Suwitree also has a plastic-film greenhouse built to produce high-price vegetables during rainy season such as multiply onions and cilantro. The greenhouse is used for drying seeds during the rainy season as well.

Suwitree's father, Banthit Daenkhanan, says that seed production is better than sugarcane farming because sugarcane price is unpredictable. Sugarcane farming on a 10-rai (1.6 ha) land can bring in 30,000 to 40,000 baht. With seed production, they only need a 2-rai (0.36 ha) land and can produce 3 crops a year, making sufficient income.

At this point, Suwitree is committed to this career as a seed farmer. She plans to set up a network of seed farmers in her community to produce and supply seeds to a seed company. She now has four members – her relatives – in her network. She re-invests her earnings in

the farm equipment such as a water pump and an irrigation system to help save time and labor. In her free time, Suwitree gives a talk to school kids and people in her community, educating them about the importance of high-quality seed and seed preservation.

"Training Program for New Seed Producers" is an initiative of NSTDA, Maejo University, Chiang Mai College of Agriculture and Technology and seed companies. The program aims to train young graduates to become seed producers and promote this profession in the community.

EMPOWERING COMMUNITY ENTERPRISE WITH SCIENCE AND TECHNOLOGY

Non Klang Organic Farming Community Enterprise was formed by organic farmers in Non Klang Sub-district in Ubon Ratchathani Province with a prime objective to curb the use of chemicals for the health benefit of consumers and farmers and the balance of ecosystem. Before the enterprise formation, all 14 members were practicing chemical farming, relying on chemical intervention to fight pests and weeds and provide plant nutrition. All had experienced chronic sickness associated with chemical usage. It was Phiyathat Tatniyom, Founder and President of the Non Klang Organic Farm Community Enterprise who engaged his colleagues to organic farming.

Phiyathat was first introduced to NSTDA through the science village project which aims at employing science and technology to enhance the community development. Based on the community's intention to migrate from chemical agriculture to organic farming, plastic-film greenhouse technology was first suggested. The first two greenhouses were built in 2011. Despite high investment, greenhouse technology has proven its worth. Greenhouse enables year-round production and produces better quality vegetables. Their produce was accepted to Lemon Farm shop, a well-known supermarket chain specializing in organic produce and products. With promising result, more greenhouses have been built.

This initial success has boosted farmers' confidence in technology and innovations. They started attending training workshops, site visits and meetings, and sharing the experience with other farmer groups. They are keen to learn and develop skills in all aspects of organic farming, including input management, pest management, post-harvest management and marketing.

However, the key, as Phiyathat puts it, is to understand and choose proper technologies for their application.

"There are a lot of knowledge and technologies that can be applied to organic farming, but we have to study them and carefully choose the ones that can be adapted and applied to our situation," Phiyathat says. For example, vermicompost is high in phosphorus which stimulates flower bloom. "Since our group focuses on leaf vegetables, vermicomposting may not be much useful." It is also important to adopt technologies that fit with the capability. "If the technology is too complicated, it would be very difficult for us to maintain and could increase our production cost."

"In addition to technology, our enterprise strongly believes in people's potential and good management system," Phiyathat explains their philosophy. They adopted the Participatory Guarantee Systems (PGS), quality assurance systems based on active participation of stakeholders and adherence to a foundation of trust, social networks and knowledge exchange.

Today, Non Klang Organic Farming Community Enterprise becomes a learning site. Visitors come from across the country to learn about their organic greenhouse production and successful management.

Ban Nong Mang Village, situated in Non Klang Sub-district, Ubon Ratchathani Province, is one of the communities that NSTDA has been working with in employing science and technology to strengthen the community development. After a decade of working with NSTDA, farmers in this community presently earn stable income from the organic farming based on technologies and efficient management.

COMMUNITY ENTERPRISE MARKETER: A VITAL LINK BETWEEN COMMUNITY ENTERPRISE AND MARKET

"Community Enterprise Marketer is a bridge between the community enterprise and the market. We are not a middleman because we don't just buy and sell. We work with the community enterprise by helping them develop products that will be able to find a place in the market as well as guiding them through the business plan process," Achariya Sirichote defines her unique profession.

Achariya was an accounting instructor and later became a school assessor before shifting her line of work to community development by joining an organic farmer network project. She participated in the "Community Enterprise Marketer" program in 2017. Achariya spent a year learning about the principles of marketing and working with the community as well as practicing on a real case with a community in Pak Ro Sub-district, Singhanakhon District, Songkhla Province, locating 35 km. from her home in downtown Songkhla.

"Our enterprise did not have any product when we first met Achariya," recalls Mongkol Rodbuntharm, President of Koed Chak Din Community Enterprise in Pak Ro Sub-district. But what they have, Achariya observes, is determination. "I started a meeting with five representatives of the enterprise," Achariya says. Her process was to lead the group to share their thought on what the enterprise wanted to do. She asked them to identify their resources, skills, capability, problems and limitations. Achariya then made assessment. From that point on, they further developed the idea and plan together.

Koed Chak Din Community Enterprise wanted to transform their rice cultivation from chemical farming to organic farming and develop products from palm sugar, a flagship product of this area.

"Achariya guided us through the value chain concept of the products we wanted to make, and helped us identify our action plan accordingly," Mongkol says. "She encouraged us to think outside the box and unlock our potential." For instance, some farmers grew some banana trees on their land. Instead of selling banana fruits, they were introduced to other options such as processing the fruit into banana flour or go even further by making banana flour chips, a brand-new product. Instead of making palm jaggery or palm sugar cake, powdered palm sugar can potentially be their new product.

For a little over a year that Achariya and Koed Chak Din Community Enterprise started their collaboration, they are content with the progress that the enterprise has made. Members of the enterprise has shifted to organic rice farming, obtained some training on banana processing and made powdered palm sugar to test the market.

Although Achariya has completed the "Community Enterprise Marketer" program, she continues to work with Koed Chak Din Community Enterprise, hoping to see tangible results in the years to come. She has also started working with another community in Rattaphum District, Songkhla Province.

AGRITEC-NSTDA established "Community Enterprise Marketer" program with the objective to develop community members to become marketers specializing in community enterprise business. Participants are trained on the knowledge and tools to work collaboratively with the community to identify the needs of the community and customers, find local and international markets for the products and formulate a business plan.

RICE PROCESSING BUSINESS TAKES OFF FROM A FRESH IDEA

After a visit to Bhumirak Dhamachart Centre learning about the New Theory (an integrated farming practice guided by sufficiency concept) developed by His Majesty the late King Bhumibol Adulyadej, Preedathapan Junruang was so inspired that he set his sight on becoming a farmer. A master's degree graduate in technopreneurship, Preedathapan left a promising career as a factory manager and immersed himself in learning and practicing farming from experts for two years before joining his family farm in Chainat Province.

"My family was totally against me leaving a secured and promising job, but farming was my true calling," recalls Preedathapan, adding that he needs to be a smart farmer utilizing science and technology with the sufficiency philosophy in order to make it sustainable.

He asked for a 4-rai (0.64 ha) plot of his family farmland to grow organic rice. Organic rice under his "Origi Rice" brand is sold on-line through website and social media channels. His product was well received with orders pouring in. He decided to ask permission from his family to turn the rest of their family's farmland, additional 17 rai or 2.72 ha, to organic rice cultivation, and this time his family gladly obliged.

Preedathapan and 8 farmers from Young Smart Farmer Group in Chainat formed a social enterprise serving as a center to buy rice paddy from members and process into vacuum-packed organic rice. Together, they have a combined 300-rai (48 ha) land cultivating organic rice. The vacuum-packed rice is sold under Origi Rice brand through various channels. Three tons of their packed

rice are delivered annually to a private company as part of the company's CSR activity.

Though the packed rice was doing well, Preedathapan was looking for other rice-based value-added products. He attended the training workshop on rice processing business, aiming to equip interested rice farmers and entrepreneurs with knowledge to start rice processing business. Preedathapan then developed an idea for a new product, Bright - flavored pop rice tablet as a healthy snack food for kids. The product uses germinated brown organic Riceberry of the enterprise as a raw material. Before arriving at pop rice tablet, Preedathapan explored a number of potential rice products developed at several academic and research centers. The first product caught his attention was rice milk powder. But after evaluating the process and his capacity to produce rice milk, he decided that this product was not suitable for him.

Workshop participants were invited to submit a business plan for the new venture. Preedathapan's business plan was among a selected few to receive funding for prototype development. Thirty boxes of coco-flavored pop rice tablet were manufactured. Preedathapan was closely involved in all the stages, from product concept, product's name, product formula, all the way to packaging.

"After completing the prototyping process, I obtained funding from the National Innovation Agency to make further improvement on the product and a line of credit from the Bank for Agriculture and Agricultural Cooperatives to start the business with more investors subsequently joining," he remembers the journey of Bright. He is planning to add four more flavors and use other rice varieties, giving consumers more options to enjoy this nutritious snack.

AGRITEC-NSTDA and the Bank for Agriculture and Agricultural Cooperatives organized a training workshop on business and technical skills for rice-processing community enterprises and SMEs. The workshop guided participants through the process of establishing new businesses, cost structure analysis and pricing strategy, and knowledge on rice value addition, as well as provided a platform for participants to share experience.

INTRODUCTION OF AGRITEC

The Agricultural Technology and Innovation Management Institute (AGRITEC) was established under the auspices of the National Science and Technology Development Agency (NSTDA), as a one-stop service center for agricultural technologies and innovations. With mandate to accelerate technology transfer and adoption in agriculture, AGRITEC works in close collaboration with alliances from public and private sectors to "reform the agricultural sector with technology, strengthen local communities, reduce social inequality and transform Thailand to the country of bioeconomy". Thus, AGRITEC works to bridge and transfer the innovations from NSTDA and its alliance to local communities, build capacity of agricultural personnel, and provide easy-access solutions to farmers and communities.

MISSION

- Accelerate the transfer and adoption of agricultural technologies and innovations to farmers in order to improve production efficiency, add value to agricultural produce, increase income, resulting in a better quality of life for farmers and their communities.
- Evaluate technologies and make adjustment accordingly to fit the conditions and settings of each community.
- Build capacity of farmers and communities.
- Develop a sustainable network of collaboration among stakeholders in the value chain.

SOCIETY

- Create jobs
- Reduce migration from rural to urban areas
- Empower self-reliant communities
- Improve quality of life for rural communities

ECONOMY

- Reduce production cost and loss
- Raise income of people living in the rural communities

ENVIRONMENT

- Cutback chemical usage
- Alleviate forest encroachment problem
- Enable sustainable use of resources
- Promote agroforestry

TECHNOLOGY

Crop Production Technology (crop varieties / seed production / breeding /farm management)

- Rice / cassava / rubber tree / mung bean / chili / tomato / mushroom / strawberry / coffee

Eco-friendly Technology for Natural Rubber Processing

- TAP (an ammonia-free latex preservation reagent) and GRASS (a sulfuric-acid-free process for recovery of rubber waste)

Biocontrol Technology

- *Beauveria bassiana* for controlling aphids, mealybugs and brown planthopper
- NPV for controlling armyworm
- Streptomyces for controlling fungi and bacteria infecting melons

Animal Production Technology (rearing / feed)

- Fairy shrimp / Siamese plankton as aquaculture feed
- Closed-system shrimp cultivation
- Production of stingless bee queens / Quality improvement of honey
- Forage cane
- Silage
- Diagnostic kits for animal diseases
- Microorganisms for controlling foul odor in farms

Soil and Water Management Technology

- Compost from agricultural wastes
- No-turn composting
- Vermicomposting
- Irrigation system

Processing Technology

- Processing of agricultural produce
- Good Hygiene Practice (GHP) for food processing

Equipment and Machinery

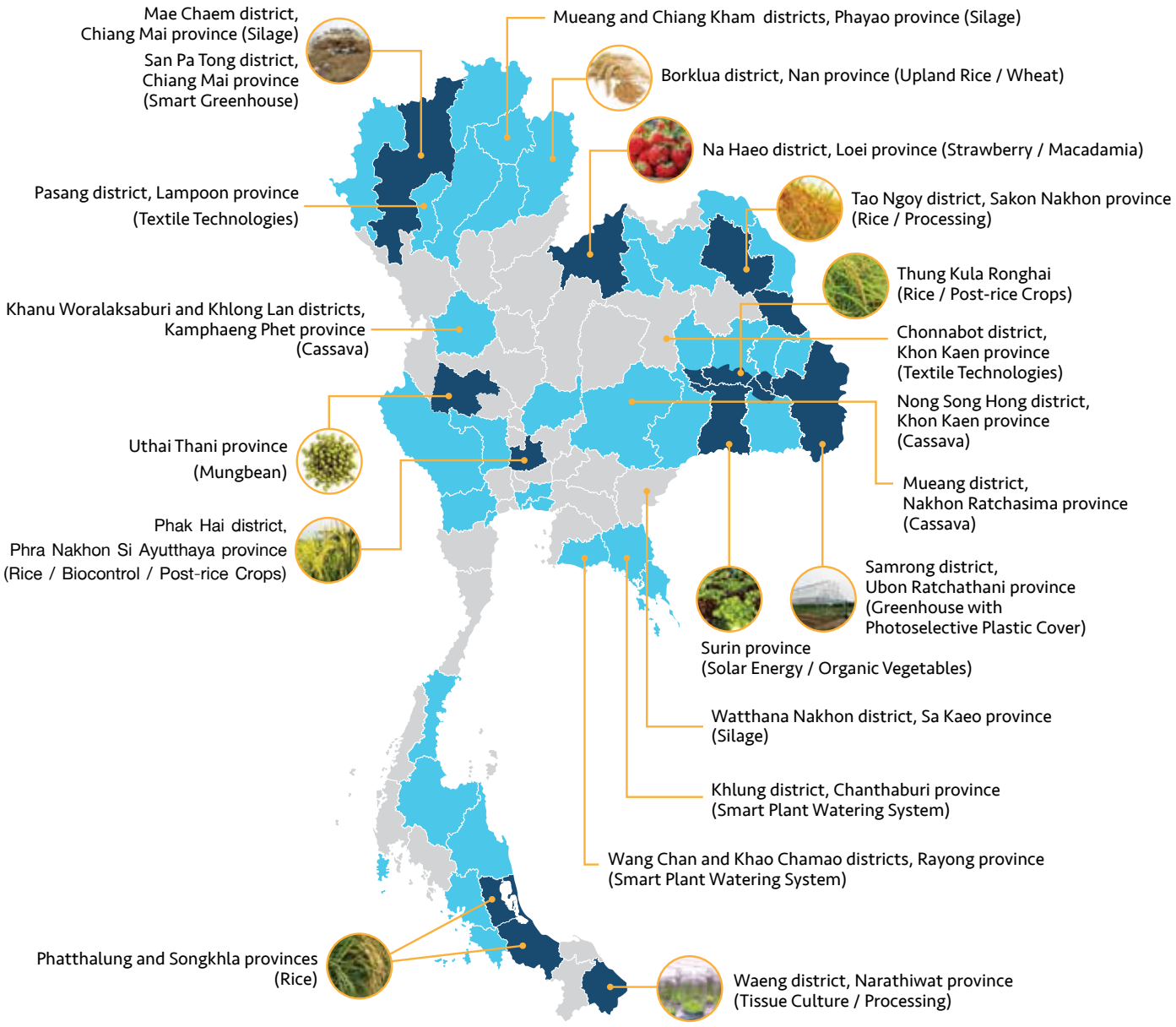
- Rice milling machine for community usage
- Photoselective plastic film greenhouse
- Drying machine/facility for agricultural products

Smart Farming Technology

- Smart greenhouse
- Weather station
- Smart watering system

Textile Technology

- ENZease (smart enzyme for desizing and scouring of cotton fabric)
- Preparation of natural dyes from local materials
- Nanotechnology to impart special properties to the fabric



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