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Deploying Innovation in the Palm Oil Industry

By Eur Ing Hong Wai Onn, Institution of Chemical Engineers and the Royal Society of Chemistry

Palm oil is commonly used as a raw material in vegetable oil, food, personal care products, and biofuels. Its production has experienced a notable rise on a global scale, increasing from 24 million tonnes in 2000/2001 to 77 million tonnes in 2022/2023. The rise in demand for palm oil is attributed to several factors such as population growth, urbanisation, and the increasing recognition of its health advantages.

In line with environmental, social, and economic challenges, the palm oil industry must prioritise innovation to remain competitive in an ever-evolving market. The deployment of innovative technologies, processes, and business models has the potential to make the industry more environmentally sustainable and efficient.

Solving the irrigation crisis

Oil palm trees are capable of withstanding short periods of drought. However, a prolonged drought usually results in reduced flowering, which in turn affects the production of fresh fruit bunches in the following harvesting cycle. With the advancements in the Internet of Things (IoT) and sensor technologies, it is possible to optimise irrigation systems by exploiting the availability of real-time field data in decision-making. Along with the economies of scale, the IoT may soon offer a viable solution for providing more reliable watering systems to plantations, and thereby stabilising yields.

The progress in implementing IoT in oil palm plantations is hindered by unreliable internet connectivity. Palm oil plantation companies can consider investing in information and communications technologies. An increase in yields and a lower operating cost will justify their investment.

CONTINUED ON PAGE 02 >>

/what's inside

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/chief editor's note

The Role of Technology in Sustainable Agri-Food Production and Circular Economy Practices

Malaysia is blessed with an abundant source of food. The proof is that 17,000 tons of food are wasted every day. However, the excess of food does not indicate food security for everyone in this country. Food security is a global issue that is complex to deal with, as evidenced by the inclusion of achieving zero hunger in the Sustainable Development Goals.

I am pleased to say that this edition of TECHIES covers the role of agriculture in ensuring an adequate supply of food in a sustainable manner. The interview section concerns current advancements in agro-food production. I believe that insight from professional technologists is crucial in propelling higher yields in the agriculture sector.

The palm oil industry is important to Malaysia's economy. A more effective and innovative management of palm oil plantations is necessary to increase its level of sustainability. Today, advanced technology can be applied in palm oil plantations and the distribution of palm oil-related products.

Recently the circular economy has been a frequently discussed topic. The palm oil industry needs to adopt and adapt this principle so that the use of resources is optimised, while waste and emissions are minimised. For instance, the use of empty fruit bunch (EFB) as mulch and fertilisers for oil palm trees reduces waste and dependency on non-organic fertilisers. Another example is, used cooking oil can be converted to sustainable aviation fuel after undergoing proper processes. These examples demonstrate that circular economy in the palm oil industry can be implemented in the plantation and after the use by end consumers.

I wish you an enjoyable experience reading this TECHIES 23rd edition. Together we strive for a sustainable future!

Zuraidah Mohd. Zain

CONTINUED FROM PAGE 01 >>

How biotechnology can help

Incorporating biotechnology in the palm oil milling process has the potential to be a game-changer for the industry. Biotechnology has the potential to unlock many new possibilities, and its adoption could be a key driver of sustainable growth in the future. By using innovative biotech processes, producers could address many of the challenges faced in the current palm oil extraction process. This could lead to improved efficiency and reduced environmental impact.

For instance, enzymes break down the cell walls of the palm oil fruit, thereby improving oil extraction efficiency without changing the quality of the crude palm oil. The Sime Darby Plantation, which is the world's largest certified sustainable palm oil producer, deploys this technology. Full-scale mill operations with an enzyme-aided oil extraction process achieves an additional 0.7% oil recovery. In turn, this extra production indirectly results in lower natural occupation impact.

Palm oil mill effluent for sustainable fuels

During the production of crude palm oil, there are unavoidable oil losses which result in the accumulation of palm oil sludge in the effluent treatment pond. This palm oil sludge is known as palm oil mill effluent (POME) . POME has the potential to become an excellent raw material in biodiesel production. Biodiesel is an alternative to traditional petro-diesel fuel. Studies suggest that biodiesel produced from palm sludge oil has a greenhouse gas emission reduction potential of over 80% compared to petro-diesel fuels. When POME is decomposed in the absence of oxygen, methane is

formed. The biogas generated in palm oil plantations can be harnessed as a renewable energy source for electricity production. Although biogas power plants are already present in many plantations, the full potential of biogas has not yet been realised - possibly due to the high capital costs associated with building substations and high-tension lines in rural areas, where palm oil mills are usually located. However, if the palm oil industry can take advantage of this renewable energy source, it will not only reduce carbon emissions but also provide affordable, reliable, and sustainable energy for people living in rural areas.

Biorefinery enables a circular economy

In addition to technological advancements, innovative business models should be explored. Circular economy aims to reduce waste and maximise resource efficiency in product and process design. By adopting its underlying principles, the industry can effectively utilise agricultural biomass, conserve resources, and create new business opportunities.

As a case in point, the palm oil industry can deploy biorefinery technology, which upgrades biomass such as oil palm trunks, oil palm fronds, empty fruit bunch, and palm kernel cake into bioethanol. This reduces greenhouse gas emissions by 86% compared to gasoline. Additionally, it also has a higher octane number, providing premium bleeding properties, which enhances engine performance.

Furthermore, when palm kernel cake is used as feedstock in bioethanol production, high-protein animal feed and dried grain with solubles will be produced as by-products. This is a residue of the yeast fermentation process. The distiller's dried grain with solubles can replace corn and soybean meals in broiler diets.

Conclusion

To remain competitive in a constantly evolving market, the palm oil industry should prioritise implementing innovative solutions to tackle the onslaught of challenges that continuously come its way. Through the adoption of innovative technologies, processes, and business models, the industry can improve its environmental sustainability and operational efficiency. Moreover, innovation can aid in dealing with the ecological and social concerns related to palm oil production, rendering it a more sustainable and ethical industry.

The writer is a chartered chemical engineer and a Fellow of the Institution of Chemical Engineers and the Royal Society of Chemistry. He is the author of "A Chemical Engineer in the Palm Oil Milling Industry"

Empty Fruit Bunches (EFB): A New Sustainable Avenue in the Sustainable World

By Ahmad Fakhri Habib and Mohamad Fakhrul Ridhwan Samsudin, Ph.D, P.Tech, CEng, MIChemE, PETRONAS Research Sdn. Bhd.

Malaysia is famous for its palm oil production and plantation. It is reported that 18.45 million metric tonnes of crude palm oil were produced in 2022 - an increase of 1.9% compared to 2021. Additionally, the total revenue of palm oil production alongside other palm-based products has witnessed a surge of growth by RM 135 million, 24.4% higher than in 2021. This has led to an increase in processing capacity as well as waste from the production activities. In recent years, a growing interest to transform this waste into a wide range of value-added creations has been seen, particularly in response to the UN Sustainable Development Goals. Indeed, transforming palm oil waste from oil palm trunks, oil palm fronds, empty fruit bunches, palm pressed fibres, palm shells, and palm oil mill effluents to other products will improve the overall utilisation of yield. This also mitigates waste disposal contamination issues that affect the environment.

Empty fruit bunches (EFB) are known as lignocellulosic biomass that can potentially create new avenue and revenue for the industry. In general, the biomass comprises three major components - lignin, cellulose, and hemicellulose. These components typically release 5-carbon and 6-carbon sugars, which can be converted into biofuels and other biochemical products. Other value-added products include biochar, mulch, fertilisers, and bioethanol. The creation of the aforesaid value-added products can significantly reduce the need for landfills to dispose of huge amounts of palm oil waste.

EFB as biochar

Biochar is a highly porous carbonaceous solid that is difficult to decompose compared to biomass. It is produced through thermal decomposition in the absence of oxygen. Recently, biochar has emerged as an important tool in wastewater treatment due to its ability to effectively treat both organic and inorganic pollutants. One of the most intriguing properties of biochar is its

“Indeed, transforming palm oil waste from oil palm trunks, oil palm fronds, empty fruit bunches, palm pressed fibres, palm shells, and palm oil mill effluents to other products will improve the overall utilisation of yield.”

carbon negative characteristic, unlike biofuels or fossil fuels which are carbon neutral or carbon positive. Thus, buried biochar can remain stable for thousands of years, resulting in carbon sequestration and improvement of soil fertility. As such, biochar has the potential to be a game-changer in mitigating climate change. Sparked by this inspiration, researchers have been exploring ways to convert EFB into biochar using thermal decomposition techniques such as torrefaction and pyrolysis. The resulting biochar has high energy capacity, which can be used as a substitute for coal in various industries. It can serve as a precursor in fuel production.

EFB as mulch and fertilisers

Another interesting avenue for EFB is its use as mulch for plantations. Mulching is the application of materials on the ground surface to reduce soil temperature and conserve soil moisture in order to improve the growth and yield of plants. Mulching also supplies nutrients such as urea, rock phosphate, muriate of potash, and kieserite as they decompose. These nutrients are needed by crops including oil palm. The process of EFB mulching is typically done once a year, depending on the need of the plantation.

The use of EFB as organic fertiliser has gained attention in recent years. This is because EFB contains a variety of nutrients essential for plant growth and development. In particular, its nitrogen content promotes leaf and stem growth, leading to enhanced plant health and vigour. Additionally, EFB is rich in potassium and phosphorus, which are crucial for root development and the production of flowers and fruits. These nutrients also play a vital role in bolstering the plant's immunity to pests and diseases. It is important to note that the nutrient content of EFB may vary, depending on the age of the tree and the method used to extract the palm oil. Therefore, proper processing and storage of EFB is essential to ensure that the nutrients are preserved. With its numerous benefits and potential applications, the use of EFB as a sustainable fertiliser is a promising solution for promoting healthy plant growth and improving agricultural productivity.

EFB as feedstock for bioethanol and bio-monoethylene glycol production

EFB can be converted into feedstock for bioethanol and bio-monoethylene glycol production. Bioethanol is a type of renewable fuel that can be produced from biomass sources. It is a good alternative to gasoline. With a higher octane rating compared to gasoline, it is deemed to be more suitable for use in fuel high-performance engines. Since it is produced from biomass sources, bioethanol is postulated to produce less greenhouse gas emissions compared to gasoline.
To add, EFB has a high potential to be a source of biomass to produce bio-monoethylene glycol, which is a key chemical used in to produce polyester fibres, polyethylene terephthalate resins, and engine coolants. The end users of monoethyele glycol include industries producing textile, kitchenware, packaging, coolants, and antifreeze. Since it is conventionally produced from fossil fuels such as natural gas and petroleum, its price volatility and shortage of supply have always been a major limiting factor. Thus, the production of monoethyele glycol from EFB creates a better and more promising avenue and revenue in the industry.

> **“Therefore, proper processing and storage of EFB is essential to ensure that the nutrients are preserved. With its numerous benefits and potential applications, the use of EFB as a sustainable fertiliser is a promising solution for promoting healthy plant growth and improving agricultural productivity.”**

Conclusion

Malaysia's palm oil production and plantation have seen an increase in production and revenue. Of late, attention has been given to transform palm oil waste into value-added products corresponding to the UN Sustainable Development Goals. In this regard, palm oil waste that has great potential is the EFB. Apart from the many potential avenues discussed in this article, there are plenty of other different types of avenues that are yet to be explored. With more technological advancements, the conversion of EFB into value-added creations will become highly feasible and more environmentally friendly.

Leveraging Technology, Community Involvement, and Expertise to Enhance Food Security in Malaysia

AN INTERVIEW WITH

Ts. Dr. Aida Hamimi Ibrahim

Deputy Director, Enzyme and Fermentation Technology Program, Food Science and Technology Research Center MARDI

Can you tell us about your qualifications and focus?

I have 27 years of experience in the field of food science and technology. My primary focus is on the development of functional and health foods. My academic qualifications include a BSc. (Hons) in Food Science and Technology from Universiti Pertanian Malaysia (UPM) in 1994, followed by a Master's in Food Technology from Massey University, New Zealand, in 1997. I completed my academic journey with a PhD. in Nutritional Biochemistry from UPM in 2010. Throughout my career, I have collaborated closely with food industries, contributing my expertise to product development initiatives. Additionally, I have provided consultancy services to MARDI Holding, specialising in setting up food incubators. My areas of specialisation encompass food processing and product development, where I strive to enhance the quality and accessibility of food products and promoting public health.

Please share your current research activities

The research I do are in two major categories – food processing and product development.

Food processing

I am currently working on research projects involving high pressure processing technology, which increases product shelf life without reducing nutritious content by combining high pressure and low temperatures. I also work in the food production industry utilising retort technology, which preserves products by applying high pressure and temperature. These two preservation techniques help small and medium-sized business owners to increase the shelf life of products and expand domestic and international market reach.

Product development

In terms of product development, my team and I create plant-based products that serve as novel sources of protein. This lessens reliance on animal products for protein. To decrease reliance on the source of carbohydrate from rice and wheat, my research also examines the source of carbohydrates from yams and tubers.

In your opinion, can negative perception towards genetically modified organisms (GMO) or other products of advanced food technology be curbed?

It takes a multifaceted approach to change people's perceptions of advanced food technologies like genetically modified organisms. There are potential advantages of GMOs in agriculture, such as higher crop yields, resistance to pests and diseases, improved nutritional value, and less environmental impact from using fewer pesticides. Furthermore, GMOs can contribute to sustainable agriculture by reducing the need for chemical inputs, conserving water and land resources, and enhancing resilience to climate change. Currently, Malaysia has approved eight genetically modified (GM) maize/corn products and six GM soybean products for food, feed and processing purposes. Approvals have also been given for the field trials of GM mosquitoes, papaya, and release of GM products for use as pesticides and fertilisers. It is important to provide accurate information about GMOs. How they are developed, tested, and regulated can help dispel myths and fears. Transparent communication about the

benefits and risks fosters trust. Hence, collaboration between scientists, policymakers, industry stakeholders, and the public should be made to develop GMOs that address pressing agricultural challenges while meeting societal needs and values.

Do you think the digitisation and automation of farms will contribute to sufficient food supply in Malaysia?

Yes, digitisation and automation in farming have the potential to significantly contribute to the agro-food sector in Malaysia. Technologies such as precision agriculture, IoT sensors, drones, and automated machinery can help farmers monitor and manage their crops more efficiently. This can lead to higher yields and better resource utilisation. Malaysia, like many other countries, faces labour shortage. Automation can help alleviate this by reducing the need for manual labour, thus ensuring that farms can continue to operate efficiently even with fewer workers. Furthermore, automation can ensure consistency and quality in agricultural processes, leading to better-quality produce. This is essential for meeting consumer demand for safe and high-quality food products. However, implementing digitisation and automation technologies can be costly, especially for smallholder farmers who may lack the financial resources. Thus, affordable financing options and government subsidies are necessary. Overall, embracing digitisation and automation in farming can enhance productivity, sustainability, and resilience in Malaysia's agro-food sector, ultimately contributing to meeting the country's food security needs.

Should we include the community in novel farming systems, such as indoor farms and smart-micro gardens to ensure food security?

Involving the community in novel farming systems like indoor farms and smart-micro gardens is highly significant for ensuring food security. It creates economic opportunities, particularly for smallholder farmers and marginalised groups. The initiatives can generate employment, income, and entrepreneurship opportunities within the community, contributing to poverty alleviation and economic development. Thus, community involvement in novel farming systems promotes food security by empowering local communities to produce their own food. Indoor farms and smart-micro gardens, for example, can enable year-round cultivation of fresh produce, reducing dependence on external food sources and mitigating the risk of food shortages. Additionally, community support can provide the necessary social capital and buy-in for the adoption of these technologies. Overall, community involvement is essential because it fosters collaboration, empowerment, and resilience, ultimately contributing to more sustainable and inclusive food systems.

> **“Overall, embracing digitisation and automation in farming can enhance productivity, sustainability, and resilience in Malaysia's agro-food sector, ultimately contributing to meeting the country's food security needs.”**

Producing sufficient agro-food is meaningless unless the food can be delivered to consumers with minimal wastage. What are the steps that can be taken to improve the agro-food supply chain in Malaysia?

Improving the agro-food supply chain in Malaysia involves various steps aimed at enhancing efficiency, reducing wastage, and ensuring timely delivery of food to consumers. There are several measures that can be taken:

- Upgrade transportation networks, including roads, railways, and ports, to facilitate the smooth movement of agricultural products from farms to markets. Improving cold storage and refrigeration facilities is also essential for preserving perishable goods during transit.
- Implement tracking and tracing technologies such as RFID tags, barcodes, and GPS systems to monitor the movement of food products throughout the supply chain. This enhances visibility and transparency, allowing for better inventory management and timely interventions to prevent spoilage or loss.
- Establish and enforce standards for packaging, labeling, and handling of agricultural products to ensure consistency and quality throughout the supply chain. Implement rigorous quality control measures to detect and eliminate contaminated or defective products before they reach consumers.
- Encourage the sourcing of agricultural products from local farmers and producers to reduce reliance on imports and shorten supply chains. Establish direct procurement arrangements between retailers, food service providers, and local farmers to ensure a steady market for locally grown produce.
- Inform consumers on the value of reducing food waste and making wise judgements while making purchases. Provide information on proper storage and handling techniques to extend the shelf life of perishable products and reduce spoilage at the household level.

By implementing these measures, Malaysia can enhance the efficiency and resilience of its agro-food supply chain, ensuring that sufficient food reaches consumers with minimal wastage. Collaboration, innovation, and investment in infrastructure and technology are key to achieving these goals and building a more sustainable food system.

A mission to achieve food security requires a collective effort by many parties. What can professional technologists and certified technicians do to help achieve this mission?

Professional technologists and certified technicians can make significant contributions to achieving food security through their expertise in various fields. Professional technologists can develop and implement innovative

technologies to improve agricultural practices, increase productivity, and reduce post-harvest losses. This may include precision farming technologies, IoT devices for monitoring crops and soil conditions, automated irrigation systems, and advanced machinery for planting, harvesting, and processing crops.

Certified technicians can ensure compliance with food safety standards and quality assurance protocols throughout the food supply chain. They can conduct regular inspections, audits, and testing of agricultural products to detect and prevent contamination, spoilage, and adulteration, thereby safeguarding public health and consumer confidence.

Both professional technologists and certified technicians can provide training and capacity building programs for farmers, agribusinesses, and food processors to enhance their knowledge and skills in areas such as crop management, pest control, food processing, and food safety. This empowers stakeholders to adopt best practices that improve productivity, efficiency, and food quality.

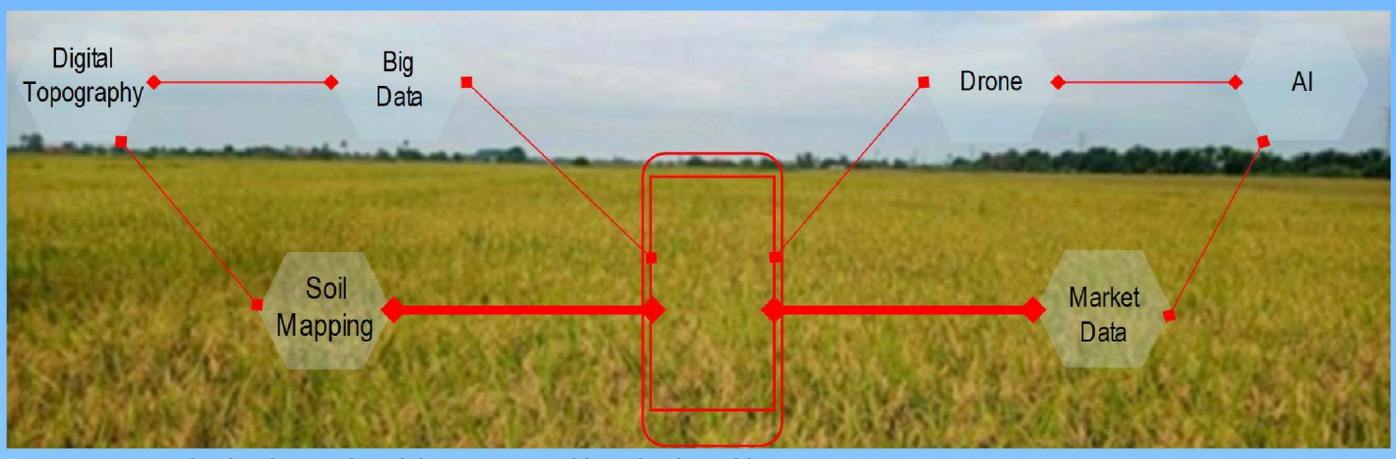
In short, professional technologists and certified technicians play a vital role in advancing agricultural development and food security through their expertise, innovation, and dedication to improving the efficiency, sustainability, and resilience of food systems. By collaborating with other stakeholders and leveraging their skills and knowledge, they can contribute to achieving the shared goal of ensuring that everyone has access to safe, nutritious, and affordable food.

By Mohd Najib bin Mohamad, TNB Energy Services Sdn Bhd

Sustainable Technology:

Transforming Food Security for a Brighter Future

Food security is a pressing global issue as the world's population continues to grow, placing immense pressure on the world's agricultural systems. However, the convergence of sustainable technology and food security offers hope for a brighter and more sustainable future. By harnessing innovative technology, the challenges of climate change, resource scarcity, and population growth can be addressed, while ensuring access to safe, nutritious, and sufficient food for all. This article explores the transformative potential of sustainable technology in enhancing food security and highlights key technological advancements in agriculture and food production.



Farmer managing his/her farm with mobile apps accessible on his/her tablet.

Food security encompasses availability, access, utilisation, and stability of food supplies. However, several challenges hinder its achievement. Firstly, climate change disrupts agricultural productivity, leading to crop failures, water scarcity, and increased vulnerability to pests and diseases. Secondly, limited access to resources such as land and water hampers agricultural productivity, particularly in marginalised communities. To add, inefficient post-harvest management and food waste contribute to losses along the supply chain. Lastly, population growth and urbanisation strain food systems, necessitating sustainable solutions to meet future demands.

Some sustainable technology solutions to transform food security are:

(a) Precision agriculture

This solution leverages technology, including sensors, drones, and satellite imagery to optimise farming practices. It enables precise application of water, fertilisers, and pesticides, which reduces resource waste and environmental impact. By adopting precision agriculture techniques such as remote sensing, farmers can monitor crop health, predict yield, and enhance resource management.

(b) Vertical farming and controlled environment agriculture

These involve cultivating crops indoors using stacked layers or controlled environments. The methods optimise land use, conserve water, and reduce dependence on pesticides. By integrating technologies such as LED lighting, hydroponics, and automation, vertical farming can produce high-quality, year-round crops in urban areas, reducing transportation costs and carbon emissions.

(c) Aquaponics and hydroponics

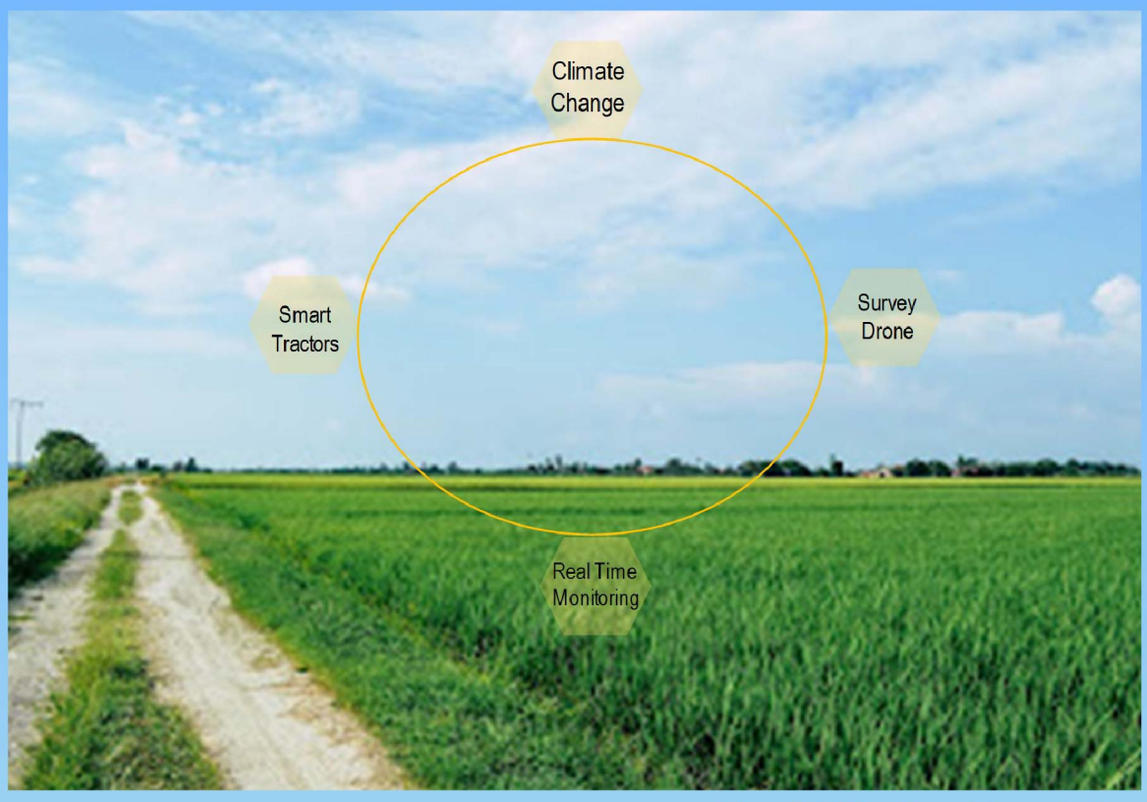
Both techniques are soil-less cultivation that minimises water usage and maximises crop yields. Aquaponics combines aquaculture (fish farming) and hydroponics (growing plants in nutrient-rich water), creating a symbiotic relationship where the fish waste fertilises the plants. Hydroponics allows plants to grow in nutrient solutions, conserving water and eliminating soil-borne diseases.

(d) Conservation agriculture

Conservation agriculture promotes sustainable farming practices including crop rotation, cover cropping, and minimum tillage. By reducing soil disturbances, conserving moisture, and improving soil health, conservation agriculture minimises erosion, enhances biodiversity, and increases crop resilience. Sustainable technology tools such as GPS-guided machinery and precision planting equipment facilitate implementation.

(e) Digital farming and data analytics

Digital farming integrates technology, data analytics, and farm management software to optimise decision-making. By collecting and analysing data on weather patterns, soil conditions, and crop health, farmers can make informed choices about planting, irrigation, fertilisation, and pest management. Data-driven insights improve efficiency, reduce waste, and enhance productivity.



Internet of Things in precision agriculture.

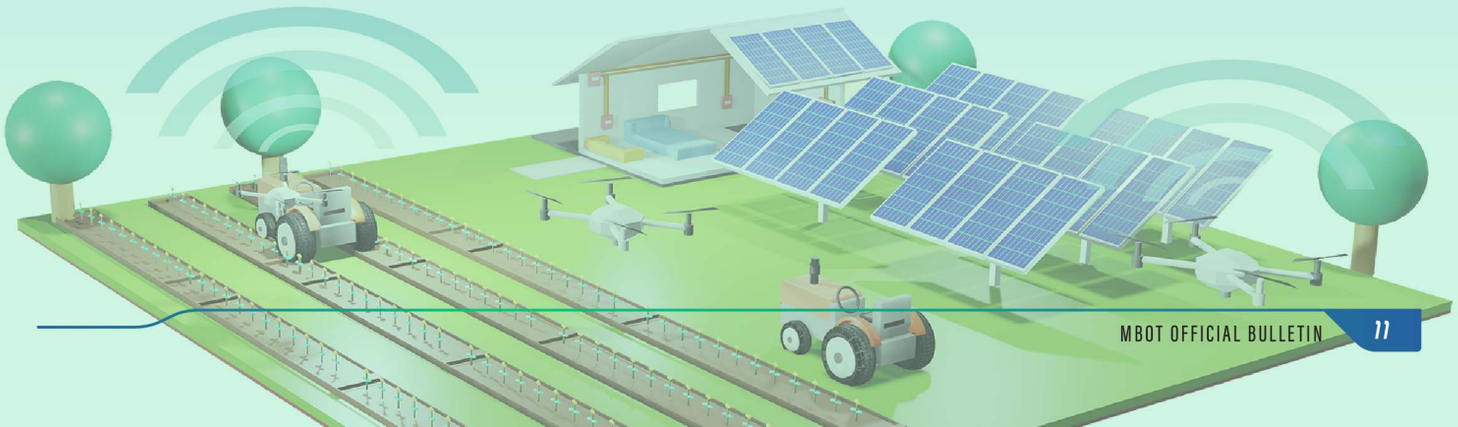
(f) Blockchain and supply chain traceability

Blockchain technology provides transparent and secure supply chain traceability, ensuring food safety and reducing fraud. By recording every transaction and movement of food products, blockchain enables consumers and stakeholders trace upstream production methods and handling practices, which in turn fosters trust and accountability in the food system.

The adoption of sustainable technology in food security initiatives yields numerous benefits. Firstly, it enhances agricultural productivity, enabling farmers to produce more food with fewer resources. Increased productivity can meet growing food demand, especially in regions experiencing rapid population growth. Secondly, sustainable technology minimises resource consumption such as water and energy, reducing the environmental footprint of agriculture. In addition, it empowers smallholder farmers by providing access to information on market and financial services, thus contributing to poverty alleviation. Furthermore, sustainable technology solutions create employment opportunities in the agricultural technology sector and support rural development. Lastly, the adoption of sustainable technology in food security efforts contributes to mitigating climate change by reducing greenhouse gas emissions, preserving biodiversity, and promoting sustainable land and water management practices.

In short, sustainable technology has the potential to address the challenges of the current food system and the issue of food security. The utilisation of various innovative approaches enable the optimisation of resource use, productivity, and access to safe and nutritious food. The benefits extend beyond enhanced food security to encompass economic development, environmental sustainability, and social empowerment. The integration of sustainable technology into our food system is not only crucial for achieving food security but also for promoting sustainable development, reducing environmental impact, and building resilient communities.

In essence, sustainable technology is an investment that is capable of assuring a brighter and more secure future.



MBOT TECHNOLOGY & TECHNICAL WORKING GROUP (TTWG) 2024

The Malaysia Board of Technologists (MBOT) has initiated the activation of the Technology and Technical Working Group (TTWG) this year with the implementation of the TTWG Workshop held at the Ibis Hotel, Kuala Lumpur.

The two-day workshop aims to assist the Board in developing guidelines related to technology and technical services in the fields of technology recognized by MBOT. Additionally, the workshop will discuss matters concerning the use of the official stamp of Professional Technologists (Ts.) and Certified Technicians (Tc.).

The workshop commenced with a welcoming speech by YBrs. Dr. Md Fauzi Md Ismail, Registrar of MBOT, followed by a sharing session on the New Industrial Master Plan 2030 (NIMP 2030) by representative from the Ministry of Investment, Trade and Industry Malaysia (MITI), YM. Dr. Tengku Zahaslan bin Tuan Hashim, Senior Assistant Director, Industrial Development Division of MITI. YBhg. Prof. Datuk Ts. Ir. Dr. Siti Hamisah binti Tapsir, President

of MBOT, also attended to share the latest developments and MBOT's plans for 2024.

The workshop was attended by more than 100 TTWG members comprising government agencies, industries, and academics from 24 technology and technical fields recognized by MBOT.

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48,965	10,449	22,447	2,971
Graduate Technologists	Qualified Technicians	Professional Technologists	Certified Technicians

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