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What Does it Take to Transform Malaysia's Agriculture Sector into a High-Tech Industry?

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The application of artificial intelligence (AI) in the agricultural sector dates back to the early 1980s, when robotics research was conducted in Japan to support farm operations, followed by the development of the first cotton crop simulation model (GOSSYM) in Greece in 1985[1]. Even though AI has been used in agriculture for over 40 years, it was not until 2011 when the concept of Agriculture 4.0 was popularised, that it was applied and developed more widely.

The application of AI in agriculture has been a subject of interest, especially with the emergence of Agriculture 5.0[2]. Throughout centuries, agriculture has evolved from manual power and animal labour (Agriculture 1.0) to the usage of machinery, pesticides, and fertilisers (Agriculture 2.0). This was followed by precision farming techniques in Agriculture 3.0 and the era of smart agriculture in Agriculture 4.0. Currently, Agriculture 5.0 takes it a step further by integrating technologies such as big data, AI, and the Internet of Things (IoT) with renewable energy sources[3]. While the primary goal

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[1] Zha (2020)
[2] For further information on the concept of Agriculture 1.0 to 5.0, please refer to this paper by Haloui et al. (2024)
[3] Ragazou et al. (2022)

of agriculture has always been to improve productivity, Agriculture 5.0 simultaneously aims to significantly reduce the environmental impact of the sector.

Initiatives to introduce digital technology in Malaysia's agriculture sector are already underway. One example is the Digital Agtech programme by the Malaysia Digital Economy Corporation (MDEC). This initiative aims to integrate digital technologies into farming, with the strategic vision of transitioning the sector into an industry that is highly skilled and digitally driven[4].

Another example is the *Smart Sawah Berskala Besar* (Smart SBB)[5] programme, which specifically aims to increase paddy yield per hectare. This initiative integrates digital technologies such as drones for crop monitoring and input spraying, as well as AI-based irrigation systems, among many others[6]. It allows farmers to employ digital technologies in an economy-of-scale framework, which has resulted in increased efficiency and productivity in rice cultivation[7].

Despite the initiatives and efforts, digital technology has not been fully integrated into the agricultural sector in Malaysia. Currently, it is only accessible to a small portion of farmers or is focused on a specific subsector (e.g. paddy and palm oil)[8]. Several underlying factors hinder the broader adoption of digital technology among Malaysian farmers. These include infrastructure and resource-related, economic, political, and social barriers, which will be further explained in this paper.

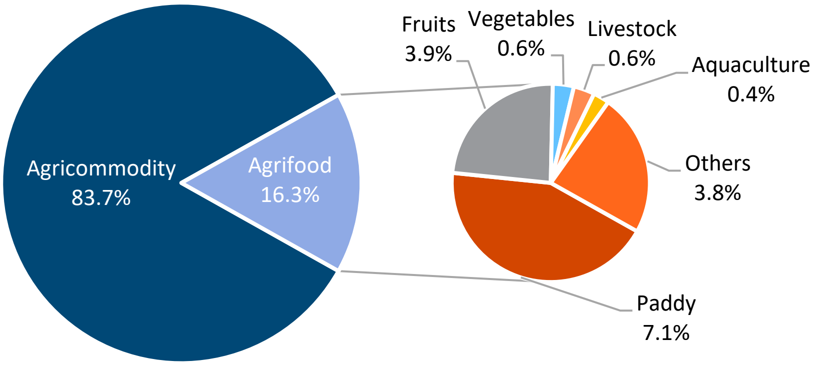
Before delving into the hurdles that need to be tackled for the sector to be fully modernised, this paper will first assess the current challenges of Malaysian agriculture and explore how technologies, focusing specifically on AI, can benefit the sector.

The Challenges of Malaysian Agriculture

Malaysia's agricultural landscape is primarily dominated by agricommodity (e.g. palm oil, rubber) due to its significant economic importance[9]. Currently, agricommodity plantations occupy 83.7% of the total agricultural land, leaving only 16.3% for agrifood production (Figure 1)[10]. While palm oil undoubtedly contributes substantially to the country's GDP and provides income for many smallholders, there is an increasing need to produce more food to support the growing population and to ensure food security in the face of potential future global events similar to the Russia-Ukraine conflict[11] or the Covid-19 pandemic.

[4] MDEC, n.d.
[5] Smart SBB is an initiative by the Ministry of Agriculture and Food Security (MAFS) that emphasises contract farming and public-private partnerships to boost paddy productivity.
[6] KPKM (2024)
[7] Ibid.
[8] Mat Lazim et al. (2020)
[9] Hussein, Siwar, and Adham (2017)
[10] Ministry of Economy (2023)
[11] Further reading on the impact of the Russia-Ukraine conflict on the agriculture sector/food security may be found here

Figure 1: Proportion of agricultural land use by subsector, 2021



Source: Ministry of Economy (2023)

The limited availability of agricultural land for food production can lead to the intensive use of the remaining croplands. This can place immense pressure on the soil, potentially leading to soil degradation. According to the Food and Agriculture Organisation (FAO), 33% of the world's land is already degraded due to factors such as erosion, salinisation, acidification, or chemical pollution[12]. Applying further pressure to this limited land will eventually reduce productivity and overall food production over time. This will pose a challenge for Malaysia, as the country already has the lowest agricultural total factor productivity (TFP)[13] compared to neighbouring Southeast Asian countries such as Vietnam, Indonesia, Thailand, and the Philippines[14].

Another challenge to Malaysia's agricultural sector is climate change. Weather patterns, such as changes in rainfall patterns and temperature increases, have historically posed and will continue to pose significant threats to food production. The Malaysia Third National Communication and Second Biennial Report to the UNFCCC briefly discussed the potential impacts of climate change on Malaysia's agriculture sector. These impacts include a reduction in rice yield by 10-30% in the three main rice granary areas by 2050[15]. For livestock, excess rainfall may lead to issues such as water-related diseases, or higher temperatures may lead to the rapid development of vector-transmitted diseases, affecting livestock's growth and productivity. In the fisheries and aquaculture subsector, changes in water temperature or quality due to floods and droughts may create environments less optimal for many species to survive[16].

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[12] FAO (2015)
[13] TFP is the measure of agricultural output generated from the combined use of land, labour, capital, and material resources in farm production.
[14] USDA (2023)
[15] MESTECC (2018)
[16] Ibid.

Apart from the issues of limited land for food production, soil health, and climate change, Malaysia's agriculture sector also faces a lack of interest among people to work in this field. This may be due to various factors such as rural-urban migration, low wages, and the hard labour nature of the job. Over time, Malaysia has seen a decline in agricultural employment as a percentage of total employment, dropping from 19% in 1990 to just 10% in 2022[17].

How can AI be Beneficial to the Agriculture Sector?

Technology plays a crucial role in addressing many agricultural challenges, though it may not solve all of them. AI has been transformative in agriculture; one such example is its ability to leverage data to perform predictive analytics and offer innovative solutions to farming. AI-powered systems encompass a wide range of technologies, including robotics and automation, drones, IoT, sensor technology, and intelligent decision-making algorithms, among many others[18]. These applications are particularly advantageous as they span across all subsectors of agriculture including crops, livestock, and aquaculture.

Zooming into AI functions for crops, one example is pre-planting soil management. This involves the assessment of soil health by determining properties such as nutrient availability, pH value, and moisture content to ensure optimal conditions for planting[19]. By analysing these data, AI can recommend appropriate fertilisation and irrigation requirements based on specific soil conditions. These tailored recommendations may help enhance soil fertility, improve crop quality and quantity, and reduce the risk of soil erosion and pollution risk. Another application of AI for crops is the monitoring and detection of pests, diseases, and weeds. FAO estimates that 40%[20] of global crop yields are lost annually to pests and diseases, making this technology crucial for preventing major crop and farm losses.

The vulnerabilities presented by climate change create opportunities for further AI functionality, where past weather data from meteorological stations, weather sensors, or third-party meteorological services can provide information such as rainfall patterns and temperature changes[21]. These data are analysed to understand historical trends and frequency of weather changes. Using statistical methods and machine learning algorithms, future weather conditions can be predicted, identifying optimal strategies for planting[22]. This helps farm workers plan their harvests throughout the year and minimise the risk of severe damage from unexpected weather conditions.

Some ways AI is used to manage livestock and aquaculture are real-time monitoring of characteristics, growth, feeding behaviour, movement patterns, illnesses, and environmental variables; prediction; and risk management[23]. For instance, machine vision can be used to

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[17] ILO (2024)
[18] Wakchaure, Patle, and Mahindrakar (2023)
[19] Zhang, Yang, and Lu (2024)
[20] FAO's Plant Production and Protection Division (2022)
[21] Hachimi et al. (2022)
[22] Ibid.
[23] Patel et al. (2022); Neethirajan (2023)

determine whether fish exhibit any strange patterns on their bodies, such as lesions, deformities, or discolouration that may signal illness or infections, or AI-based sensors can be used to detect heat stress based on livestock's unusual body temperature[24]. Once these irregularities are detected, alerts are sent, enabling prompt action to prevent bigger issues, such as outbreaks.

Tackling Barriers Prior to Sector's Modernisation

Barriers must be addressed before the agriculture sector can be modernised and reap the benefits of not just AI but technology in general. Technology has been central to Malaysia's agricultural policies, with documents such as the National Agrofood Policy 2.0 (NAP 2.0) and the Twelfth Malaysia Plan emphasising its use as key to the sector's development. However, the sector still faces many deep-rooted complexities.

Barriers to modernising the Malaysian agriculture sector can be analysed from four angles: infrastructural and resource-related, economic, political, and social. While existing literature has identified numerous barriers to digital and technological adoption in agriculture, this section will focus on those relevant to the Malaysian context.

Firstly, infrastructural and resource-related barriers are the most fundamental challenges that need to be addressed before any development process can begin. This includes having a good basic infrastructure (e.g., irrigation systems), access to essential technologies (e.g., smartphones, reliable internet connectivity, farm machinery), and providing high-quality inputs (e.g., seeds, fertilisers). Currently, our agricultural sector is lacking in some of these critical areas, emphasising the need to tackle these root causes before proceeding further[25].

Second are the economic barriers to technological adoption. The high costs of adopting new technologies make it nearly impossible, especially for low-income farmers. On average, farmers in the crop, livestock, and fisheries subsectors earn RM1,524, RM2,074, and RM2,241 monthly, respectively[26]. This limited income leaves little room or budget for investing in new technologies, especially when the funds could be used for more immediate needs such as healthcare or education. The lack of access to credit is also an issue, as farmers need funds to invest in technology. This problem is common in agriculture, not only in Malaysia but globally, as farmers often lack proper farm records and credit scores, making them ineligible for grants or loans[27].

Third are the political barriers. Transforming a sector requires strong political will to ensure that initiatives and efforts are successful and inclusive. The agriculture sector, which is composed of 65% rural farmers and a high proportion of ageing farmers[28], demands an even stronger political commitment. Over the past decade, the Ministry of Agriculture and Food Security (MAFS) has received an average annual operating budget of RM3.7 billion[29], with approximately 40-50%

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[24] Neethirajan (2021); Patel et al. (2022); Danve et al. (2023); Melak, Aseged, and Shitaw (2024)
[25] Malaysia Competition Commission (2019); The Star (2023)
[26] DOS (2023)
[27] International Finance Corporation (2014); Center for Strategic & International Studies (2022)
[28] DOS (2022)
[29] The budget for MAFS has consistently been less than 2% of the total federal operating budget.

allocated to paddy subsidies[30]. This raises the question of whether there is sufficient political will to transform the entire sector or whether the focus is limited to just a few key subsectors.

The fourth barrier to technological adoption is the social aspect, which adds the final layer of understanding of why this sector is slow to modernise. For Malaysia, several social factors need to be explored further, including the proportion of smallholder farmers, land ownership, and the reasoning behind farmers' resistance to adopting technology. Farmers' resistance to technology can be influenced by various factors such as education levels and the presence or absence of social networks and extension services that facilitate the introduction and knowledge-building of new technologies[31]. Additionally, the lack of publicly available data on Malaysia's agriculture sector makes it challenging to fully grasp the situation, particularly regarding the proportion of smallholder farmers and land ownership. Understanding these aspects is important, as farmers operating on small plots or those who do not own their land are less likely to invest in technology[32].

Conclusion

The agriculture sector is important in ensuring the country's food security, so it is imperative that the sector reach its full potential. To equip the sector with cutting-edge technologies such as AI could be one of the drivers, although it should not be the only solution. If there is a genuine commitment to modernise the sector, it is essential to bridge the gap by addressing all the challenges mentioned in this paper and to delve even deeper into issues beyond what this paper has identified. This could pave the way for a more productive and sustainable agricultural industry capable of meeting future food demand and improving the livelihoods of those dependent on it.

[30] MOF (2014)
[31] Ibid.
[32] Dissanayake et al. (2022)

References

Center for Strategic & International Studies. 2022. 'Access to Finance for Smallholder Farmers'. 2022. https://www.csis.org/analysis/access-finance-smallholder-farmers.

Danve, Ashutosh, Mehulkumar Patel, Swaraj Adakney, and Yash Khalasi. 2023. 'Smart Automation in Aquaculture: Recent Advancements and Future Prospective'.

Dissanayake, C. A. K., W. Jayathilake, H. V. A. Wickramasuriya, U. Dissanayake, and W. M. C. B. Wasala. 2022. 'A Review on Factors Affecting Technology Adoption in Agricultural Sector'. *Journal of Agricultural Sciences – Sri Lanka* 17 (2):280–96. https://doi.org/10.4038/jas.v17i2.9743.

DOS. 2022. 'Labour Force Survey Report Malaysia 2021'. Putrajaya.

———. 2023. 'Annual Economic Statistics Agriculture'.

FAO. 2015. *Status of the World's Soil Resources: Main Report*. Rome.

FAO's Plant Production and Protection Division. 2022. FAO. https://doi.org/10.4060/cc2447en.

Hachimi, Chouaib El, Salwa Belaqziz, Saïd Khabba, Badreddine Sebbar, Driss Dhiba, and Abdelghani Chehbouni. 2022. 'Smart Weather Data Management Based on Artificial Intelligence and Big Data Analytics for Precision Agriculture'. *Agriculture* 13 (1):95. https://doi.org/10.3390/agriculture13010095.

Haloui, Doha, Kenza Oufaska, Mustapha Oudani, and Khalid El Yassini. 2024. 'Bridging Industry 5.0 and Agriculture 5.0: Historical Perspectives, Opportunities, and Future Perspectives'. *Sustainability* 16 (9):3507. https://doi.org/10.3390/su16093507.

Hussein, Mohammed Ebrahim, Chamhuri Siwar, and Khairul Naim Adham. 2017. 'The Role of Malaysian Palm Oil Industry in the Malaysian Sustainable Economic Development'. *International Journal of the Malay World and Civilisation*.

ILO. 2024. 'Employment in Agriculture (% of Total Employment) (Modeled ILO Estimate)'. https://ilostat.ilo.org/data/.

International Finance Corporation. 2014. 'Access to Finance for Smallholder Farmers'.

KPKM. 2024. 'SMART Sawah Berskala Besar (SMART SBB) Inisiatif MAFI Tingkatkan Ssl Beras Negara Dan Pendapatan Pesawah', 2024. https://www.kpkm.gov.my/bm/informasi/kenyataan-media/tahun-2021/2021/685-smart-sawah-berskala-besar-smart-sbb-inisiatif-mafi-tingkatkan-ssl-beras-negara-dan-pendapatan-pesawah.

Malaysia Competition Commission. 2019. 'Market Review on Food Sector in Malaysia under the Competition Act 2010'. Kuala Lumpur.

Mat Lazim, Rabiah, Nazmi Mat Nawi, Muhammad Hairie Masroon, Najidah Abdullah, and Maryani Che Mohammad Iskandar. 2020. 'Adoption of IR4.0 into Agricultural Sector in Malaysia: Potential and Challenges'. *Advances in Agricultural and Food Research Journal* 1 (2). https://doi.org/10.36877/aafrj.a0000140.

MDEC. n.d. 'Digital Agtech'. https://mdec.my/digitalagtech.

Melak, Awoke, Tesfalem Aseged, and Takele Shitaw. 2024. 'The Influence of Artificial Intelligence Technology on the Management of Livestock Farms'. Edited by Diego Alexander Tibaduiza. *International Journal of Distributed Sensor Networks* 2024 (January):1–12. https://doi.org/10.1155/2024/8929748.

MESTECC. 2018. 'MALAYSIA THIRD NATIONAL COMMUNICATION AND SECOND BIENNIAL UPDATE REPORT TO THE UNFCCC'. Putrajaya.

Ministry of Economy. 2023. 'Mid-Term Review Twelfth Malaysia Plan'. Putrajaya.

MOF. 2014. 'Anggaran Perbelanjaan Persekutuan'. Putrajaya.

Neethirajan, Suresh. 2021. 'The Use of Artificial Intelligence in Assessing Affective States in Livestock'. *Frontiers in Veterinary Science* 8:715261. https://doi.org/10.3389/fvets.2021.715261.

———. 2023. 'Artificial Intelligence and Sensor Innovations: Enhancing Livestock Welfare with a Human-Centric Approach'. *Human-Centric Intelligent Systems* 4 (1):77–92. https://doi.org/10.1007/s44230-023-00050-2.

Patel, Hrishitva, Abdul Samad, Muhammad Hamza, Ayesha Muazzam, and Muhammad Khoiruddin Harahap. 2022. 'Role of Artificial Intelligence in Livestock and Poultry Farming'. *Sinkron* 7 (4):2425–29. https://doi.org/10.33395/sinkron.v7i4.11837.

Ragazou, Konstantina, Alexandros Garefalakis, Eleni Zafeiriou, and Ioannis Passas. 2022. 'Agriculture 5.0: A New Strategic Management Mode for a Cut Cost and an Energy Efficient Agriculture Sector'. *Energies* 15 (9):3113. https://doi.org/10.3390/en15093113.

The Star. 2023. 'Infrastructure Is Key to Agriculture, Says Professor', 2023. https://www.thestar.com.my/news/nation/2023/09/10/infrastructure-is-key-to-agriculture-says-professor.

USDA. 2023. 'International Agricultural Productivity'. https://www.ers.usda.gov/data-products/international-agricultural-productivity#:~:text=One%20of%20the%20most%20informative,resources%20employed%20in%20farm%20production.

Wakchaure, Manas, B.K. Patle, and A.K. Mahindrakar. 2023. 'Application of AI Techniques and Robotics in Agriculture: A Review'. *Artificial Intelligence in the Life Sciences* 3 (December):100057. https://doi.org/10.1016/j.ailsci.2023.100057.

Zha, Jiali. 2020. 'Artificial Intelligence in Agriculture'. *Journal of Physics: Conference Series* 1693 (1):012058. https://doi.org/10.1088/1742-6596/1693/1/012058.

Zhang, Xiaoshu, Ping Yang, and Baifang Lu. 2024. 'Artificial Intelligence in Soil Management: The New Frontier of Smart Agriculture'. Resources Economics Research Board. https://doi.org/10.50908/arr.4.2_231.